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Evaluation and Strengthening Guidelines for Federal Buildings - Identification of Current Federal Agency Programs

Building and Fire Research Laboratory
Gaithersburg, Maryland 20899

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United States Department of Commerce
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Evaluation and Strengthening Guidelines for Federal Buildings - Identification of Current Federal Agency Programs

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ABSTRACT

The National Institute of Standards and Technology (NIST), by order of the President, is developing seismic evaluation and strengthening guidelines (Guidelines for Federal Buildings) for federally owned and leased buildings. The project is overseen by the Interagency Committee on Seismic Safety in Construction (ICSSC) and funded by the Federal Emergency Management Agency (FEMA). This report develops Task 1, the identification of seismic mitigation programs. The report includes a detailed work plan and schedule for the entire project, a list of ICSSC member contacts, the results of telephone conversations with all ICSSC committee members to identify existing seismic strengthening programs, the results of detailed meetings with of seven federal agencies and four private sector organizations selected for in-depth study, and summaries of the performance objectives for all agencies and organizations. In addition, a discussion of the impact and use of ATC-28, "Development of Recommended Guidelines for Seismic Strengthening of Existing Buildings, Phase 1: Issues Identification and Resolution," for this project, excerpts of rapid screening and evaluation methods from various federal agencies, and a comprehensive list of references is included.

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EXECUTIVE SUMMARY

By order of the President, the National Institute of Standards and Technology (NIST) is developing seismic evaluation and strengthening guidelines (Guidelines for Federal Buildings) for federally owned and leased buildings for the Interagency Committee on Seismic Safety in Construction (ICSSC). The project is being funded by the Federal Emergency Management Agency (FEMA). The intent of this project is to provide agencies of the federal government with guidelines for the evaluation and mitigation of seismic hazards in existing buildings and also to ensure consistent levels of strengthening between agencies. These Guidelines for Federal Buildings are expected to be issued within a presidential order in December 1993.

The development of the Guidelines for Federal Buildings has been organized around five tasks. These include identification and assessment of existing programs, development of performance objectives, a trial design program and preparation of the guidelines. This report outlines Task 1, the identification of existing seismic mitigation programs.

Task 1 began with the development of a detailed workplan and schedule, followed by the identification of existing programs. Telephone conversations were conducted with each member agency of ICSSC. A summary of these results is given in Table 1. From the results of these discussions, seven agencies were selected for additional study. The agencies selected were: U.S. Postal Service, General Services Administration, Department of Veterans Affairs, Department of State - Foreign Building Office, U.S. Coast Guard, Department of Energy, and Department of the Navy. A personal meeting was conducted with each of these agencies, followed by a review of their published standards. In addition, four private sector organizations were selected and also studied in detail. These organizations selected were: Hewlett-Packard, Northern California Region of the Kaiser Permanente Health Plan, Stanford University, and Rocketdyne. Detailed summaries of each meeting are given in Section III and summarized in Table 2.

Based on all the gathered information, performance objectives were determined for each federal and private sector agency. These objectives are described in Section IV. Most agencies are using a life-safety performance objective for the majority of their buildings, except for a few essential facilities, where a fully functional objective is used. The engineering standard used to achieve these objectives varies from agency to agency. These performance objectives have been organized in a format consistent with those of the State of California as developed by the Seismic Safety Commission. A performance matrix of government agencies is included as Table 4. A performance matrix of private sector organizations is included as Table 5.

The scope of work also included a review of ATC-28. This document, developed by the Applied Technology Council, is titled "Development of Recommended Guidelines for Seismic Strengthening of Existing Buildings, Phase 1: Issues Identification and Resolution." The document was written to identify issues surrounding the proposed development of FEMA Guidelines for seismic strengthening. As such, it was felt that many of the issues included would be pertinent to the federal effort. This document is currently in the consensus review process.

Section V of this report describes the impact and use of ATC-28 for the federal effort and reviews ATC-28 issues for applicability to the guidelines. Each issue in ATC-28 is first grouped into those that deal with the FEMA writing/development process and those which deal with the final scope and contents of the guidelines. The process issues are, in general, not applicable to the Guidelines for Federal Buildings because of the basic difference in the development scope and schedule. The remaining issues are broken down into: a) applicable and adequate; resolution judged to apply to federal buildings, b) applicable but requires significant technical development; resolution applies to federal buildings but will require significant technical development to become viable, and c) not applicable; resolution judged not applicable to federal buildings as the issue will require development of additional policy or documentation for resolution. The majority of non-process issues are expected to be generally applicable to the Guidelines for Federal Buildings.

I INTRODUCTION

In accordance with Public Law 101-614,

> The President shall adopt, not later than December 1, 1994, standards for assessing and enhancing the seismic safety of existing buildings constructed for or leased by the Federal Government which were designed and constructed without adequate seismic design and construction standards. Such standards shall be developed by the Interagency Committee on Seismic Safety in Construction, whose chairman is the Director of the National Institute of Standards and Technology or his designee, and which shall work in consultation with appropriate private sector organizations.

This report represents a major step in the development of these standards. The Interagency Committee on Seismic Safety in Construction (ICSSC) is composed of members representing 27 governmental agencies involved with building construction or responsible for government loans for building construction. A subset of ICSSC, Subcommittee 1, is composed of 15 member agencies who represent the major building owners of the federal government. The National Institute of Standards and Technology (NIST) is currently developing seismic evaluation and strengthening guidelines for federally owned and leased buildings for the ICSSC with funding from the Federal Emergency Management Agency (FEMA). NIST has subcontracted much of this work to H.J. Degenkolb Associates and Rutherford & Chekene, Consulting Engineers. The intent of the standards is to provide agencies of the federal government guidelines for the evaluation and mitigation of seismic hazards in existing buildings, hereafter called the "Guidelines for Federal Buildings," and also to ensure some consistent levels of strengthening between agencies.

The standards to be developed for this project will build upon previous efforts by ICSSC in support of the National Earthquake Hazards Reduction Program, the President's plan to implement Earthquake Hazards Reduction Act of 1977 (Public Law 95-124). As part of that program, in March 1989, ICSSC prepared a report titled "Guidelines for Identification and Mitigation of Seismically Hazardous Existing Federal Buildings", NISTIR 89-4062, ICSSC RP-3. This report, frequently termed RP-3, consists of "Guidelines ..... intended for consideration and use as appropriate, by Federal agencies in their plans for mitigation of seismic hazards in existing buildings." RP-3 presents a systematic methodology for identifying hazardous conditions, strategies for mitigation and targets for implementation. As such, RP-3 will serve as a basic reference for the development of this project.

The present project is being developed to provide standards for the evaluation and strengthening of existing federally-owned and leased buildings, implementation guidelines, and an assessment of existing federal agency programs. The development of these standards has been divided into five major tasks. The full Scope of Work and Detailed Work Plan for the project is included in Appendix A. Task 1 involves gathering information about existing federal seismic mitigation programs. Task 2 involves assessing the seismic evaluation and strengthening programs of the six federal and four private sector programs chosen in Task 1. In addition, a matrix of performance objectives by occupancy and seismicity will be developed for the federal effort. Task 3 is the preparation of the trial design program which will identify rehabilitation costs for various strength levels that may be appropriate for seismically retrofitted structures. Task 4 is the establishment of a five-member panel for the purpose of providing peer review for the results of the project. It will be made up of private sector experts from various parts of the U.S. Task 5 involves the actual writing of the evaluation and strengthening guidelines based on results of the earlier tasks, comments of NIST, the peer review panel, and the ICSSC.

Task 1 consists of telephone conversations with all ICSSC agencies, in-person meetings with seven model federal agencies and four private sector organizations, and the collection of performance objectives for all ten public and private programs. One of the items in Task 1, "a matrix of performance objectives by occupancy and seismicity for federally owned and leased buildings," has been moved to Task 2 and is not included in this report. This Task 1 report includes:

1. Scope of Work and detailed project work plan.
2. List of ICSSC member contacts.
3. Results of the telephone interviews of ICSSC members.
4. Results of discussions with the seven agencies selected for detailed interviews.
5. Results of discussions with the four private organizations selected for detailed interviews.
6. Summaries of performance objectives for all agencies and organizations.
7. Discussion of the impact and use of ATC-28 for this project.
8. Excerpts from agency rapid screening and evaluation procedures.
9. Comprehensive list of references.

Parallel to this effort, FEMA is currently developing nationally applicable guidelines for the seismic strengthening of existing buildings. It is planned to be a joint project between the Building Seismic Safety Council (BSSC), the Applied Technology Council (ATC), and the American Society of Civil Engineers (ASCE). The guidelines to be developed by the BSSC group are to be completed in six to eight years. This document will hereafter be referred to as the "FEMA Guidelines". The federal effort is intended to be consistent with the FEMA effort and to this end, liaison will be maintained between the two groups to aid in coordination.

Over the past ten years, a substantial effort has been made to develop procedures for the seismic evaluation and strengthening of existing buildings. A number of the resulting documents related to current thinking in this field are referred to in this report and will be an integral part of these standards. The following summary provides an abbreviated "nickname" for each report, its full name, and a brief background and description of the report contents:

ATC-14: Methods for Evaluating the Seismic Resistance of Existing Buildings:

> ATC-14 was the first generation document which developed a procedure for the seismic evaluation of existing buildings based directly on the performance of buildings in past earthquakes. The procedure is intended at evaluating life-safety concerns.

ATC-22: A Handbook for Seismic Evaluation of Existing Buildings (Preliminary):

> ATC-22 was the second generation document. It built upon ATC-14 by refining the procedures, expanding the commentary type information, and incorporating the strength design concepts of the NEHRP provisions for new buildings. The document format was modified into a handbook for easier use by evaluating engineers.

ATC-26-1: U.S. Postal Service Procedures for Seismic Evaluation of Existing Buildings (Interim):

> A complete procedure for evaluating existing Postal Service facilities based on ATC-22 and other available methods.

ATC-26-4: U.S. Postal Service Procedures for Seismic Retrofit of Existing Buildings (Interim):

PresentS guidelines for the seismic retrofit of existing buildings (15 building types) and nonstructural elements tailored to the Postal Service needs.

ATC-28: Development of Recommended Guidelines for Seismic Strengthening of Existing Buildings Phase 1: Issues, Identification and Resolution:

ATC-28, identifies and discusses all the issues that must be considered, resolved and included in the FEMA guidelines for the seismic strengthening of existing buildings.

Tri-Services Manual: TM5-809-10, NAVFAC P-355, AFM 88-3, Chapter 13: Seismic Design for Buildings:

A seismic design manual prepared by the Army, using the static load approach. Latest edition written in 1982. The 1991 Edition is approved for publication.

P-355.1: TM5-809-10-1, NAVFAC P-355-1, AFM 88-3, Chapter 13, Section A: Seismic Design Guidelines for Essential Buildings:

A seismic design manual for new, essential buildings, prepared by the Army, using the dynamic loading approach. Latest edition 1986.

P-355.2: TM5-809-10-2, NAVFAC P355-2, AFM 88-3, Chapter 13, Section B: Seismic Design Guidelines for Upgrading Existing Buildings:

A manual prepared by the Army outlining a methodology for screening and evaluating of existing buildings to determine their vulnerability to seismic events. It also includes recommendations for detailed structural analysis. Latest edition 1988.

H-08-8: Earthquake Resistant Design Requirements for VA Hospital Facilities:

Seismic design guidelines for new and existing construction prepared for the Department of Veterans Affairs. These guidelines were first adopted in 1973, have been updated on a regular basis and are currently under substantial revision to make them consistent with model building codes.

UBC: Uniform Building Code:

The current standard of practice for seismic design in the Western United States. The seismic provisions within the UBC were adapted from the Structural Engineers Association of California (SEAOC) "Blue Book". The current edition of the UBC was written in 1991.

UCBC: Uniform Code for Building Conservation:

The UCBC establishes life-safety requirements for all existing buildings that undergo alteration or change in use. It is predominantly used for the seismic rehabilitation of unreinforced masonry structures (Appendix Chapter 1).

Title 24: State of California; California Administrative Code:

Title 24 includes the seismic design requirements for California hospitals. It is composed of the 1988 edition of the UBC with 1989 edition of the California Amendments. It is the intent that hospitals designed to meet these provisions will remain functional after the design level earthquake.

FEMA Guidelines: Guidelines for the seismic strengthening of buildings nationwide currently under preparation for FEMA by a joint effort of BSSC, ATC and ASCE.

NEHRP Provisions: NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings: Part 1 - Provisions:

Seismic design guidelines for new buildings developed by BSSC for FEMA. Current version dated 1991.

FEMA Evaluation Handbook: NEHRP Handbook for the Seismic Evaluation of Existing Buildings:

Currently in the balloting process, this follow-up document will be the final, consensus version of ATC-22, and will represent NEHRP's evaluation guidelines document.

FEMA Techniques Handbook: NEHRP Handbook of Techniques for the Seismic Rehabilitation of Existing Buildings:

Also in the balloting process, this document will be the final consensus version of the seismic strengthening techniques originally developed for FEMA by URS/Blume in 1989.

Guidelines for Federal Buildings: This document will become the seismic evaluation and strengthening guidelines for existing federally owned and leased buildings.

A number of different qualified levels of seismic performance, or performance objectives, have been identified. Typical performance objectives include fully functional, repairable damage, life-safety, and risk-reduction. For the purposes of this report, these levels of expected performance are defined as follows:

fully-functional: Fully functional implies minimal post-earthquake disruption with some nonstructural repairs after a design earthquake. As much as possible, the building is to remain fully functional immediately after a major event. Repairs can be completed within a few hours.

repairable damage: Repairable damage implies some structural and non-structural damage but no damage that will significantly jeopardize life. Repairs can be completed in a few days up to a few months.

life-safety: Life-safety implies significant damage that might not be repairable but no damage that will significantly jeopardize life.

risk-reduction: Risk-reduction implies significant irreparable damage and possibly some falling hazards. Building may be a complete loss but the hazard to life is still low. Repairs may never be completed.

These descriptions are based on the State of California, Seismic Safety Commission Report SSC 91-1, Policy of Acceptable Levels.

II IDENTIFICATION OF AVAILABLE PROGRAMS

The first task of this project involved gathering pertinent information from the various federal government agencies represented on the ICSSC. Each ICSSC committee member was contacted by phone with the expectation that these committee members would lead to people within their agency that would have the needed information. A complete list of contacts at each agency is given in Appendix B.

In order to maintain consistency in the information gathering process, forms were developed for both the telephone conversations and the in-person meetings. The telephone conversation was aimed at obtaining a general overview of each agency's program and at deriving the information needed to select the programs to be investigated in more depth. The telephone conversations concentrated on out if the agency has an earthquake hazards mitigation program and identifying the contents of the programs that do exist. It also identified the size of the agency, how many buildings it has and if a building inventory is available.

Telephone conversations were conducted with 30 agencies between November 14 and 22. At the conclusion of the conversations, each agency was grouped into one of the following categories: a) those agencies with complete, in-place seismic programs for existing buildings, b) those agencies that own buildings but do not have a program, c) those agencies that lease their space from GSA and therefore depend on GSA's program, and d) those agencies that have no buildings but give federal loans for building construction.

The key group consisted of those agencies that had complete seismic strengthening programs in operation. The programs were found to vary considerably, with most agencies having done some seismic strengthening projects. The agencies with complete, in-place programs for seismically strengthening existing buildings included:

U. S. Postal Service
U. S. General Services Administration
Department of the Navy
Department of Veterans Affairs
Department of State - Foreign Building Office
Department of Energy
U. S. Coast Guard
Department of the Army
Department of the Air Force

Since time and funds were limited, only seven of the agencies listed above could be scheduled for in-depth meetings. Since the Army, Navy and Air Force programs are based on the same set of manuals, it was decided that only one of these three should be included in the in-depth meetings. The Department of the Navy was selected for inclusion in these meetings.

A number of other agencies have buildings; but have no established complete seismic strengthening program, are just starting a program, rely on other agencies for their program, or do not have enough buildings at risk to warrant a full program. The agencies include:

Department of Education
Health and Human Services
Housing and Urban Development
Department of Justice - Federal Bureau of Prisons
National Aeronautics and Space Administration (NASA)
Smithsonian
Tennessee Valley Authority (started).

Agencies that lease most of their office space from GSA are:

Department of Commerce
Department of Interior
Department of Justice
Nuclear Regulatory Commission (NRC)
Small Business Administration
Department of Treasury.

Agencies that have no buildings but give loans for construction are:

Department of Agriculture
FEMA.

A summary of each agency's status is included in Table 1.

Note that some agencies, such as the Soil Conservation Service, Rural Electrification Administration, Forest Service, and Agricultural Research Service of the Department of Agriculture were not reviewed.

As required in the scope of work, four private sector organizations with a complete seismic program including screening, evaluation and strengthening criteria were selected for detailed investigation. These were selected from programs that were familiar to the sub-contractor, and also represented a cross-section of private-sector concerns. The organizations chosen included: Hewlett-Packard, Kaiser Foundation Medical Plan, Stanford University and Rocketdyne.

III SUMMARY OF INFORMATION RELATED TO AVAILABLE PROGRAMS

The detailed meeting topics outline was used as a guide during the in-person interviews in Washington D.C. Since not all of the agency programs fit neatly into all of the categories, the outline was not always filled out completely. The main objective of the meeting was to consistently obtain information that related to the decision-making process used by each agency in their earthquake hazards mitigation program. A copy of the detailed interview topics form is included in Appendix D.

The in-depth meetings took place during the week of December 2-5 in Washington D.C. with the sub-contractor meeting with each of the seven selected federal agencies. Each meeting lasted for approximately three hours and covered all of the issues addressed on the detailed meeting topics outline. The following program summaries labeled "Overview of Program" contain a brief summary of each agency's program. Sections labelled "Agency Issues" describe topics of concern raised by each agency. Many of these complex issues are similar between agencies. Several agencies have asked that the Guidelines for Federal Buildings cover these difficult areas. The "Reference Documents" section contains a short list of documents used by the agency in their seismic mitigation program. All of these documents are also listed as references in section VI.

A. Government Agencies

1. U.S. Postal Service

Overview of Program

The U.S. Postal Service Seismic Hazard Reduction Program began in 1977 after the passage of the National Earthquake Hazards Reduction Act. It is in the process of being bolstered by various ATC projects. Five ATC documents are being developed covering evaluation, strengthening and post-earthquake safety evaluation. These documents include ATC-26-1, "USPS Procedures for Seismic Evaluation of Existing Buildings," and ATC-26-4, "USPS Procedures for Seismic Retrofit of Existing Buildings". ATC-26 is a cost study for the entire Postal Service program and ATC-26-2 and ATC-26-3 are postearthquake evaluation procedures. ATC-26-1 and ATC-26-2 are presently complete. ATC-26-3 and ATC-26-4 will be completed early in 1992. The USPS program includes procedures for rapid screening, preliminary and detailed building evaluations, retrofit procedures and non-structural guidelines and details. The USPS has embarked on a pilot program to investigate 110 buildings to validate the overall effectiveness of their program.

The primary performance objective for evaluating and strengthening existing USPS facilities is life-safety based on a minimum of 80% of the current NEHRP lateral force provisions. Facilities deemed essential to the operation of the USPS may be evaluated and strengthened to a more stringent requirement. Nonengineered wood-framed and metal buildings are excluded from the structural evaluation provisions; however, they are included in the nonstructural evaluation. Currently, the USPS is evaluating the applicability of the UCBC provisions for seismic retrofit of unreinforced masonry buildings.

The USPS rapid screening procedure is based on a custom database of USPS buildings and on questionnaires filled out by building managers. The buildings are ranked based on: framing type, number of employees, seismic zone (NEHRP), age, height, configuration and size (greater than or less than 3000 sq. ft.). The buildings are put into four groups, with Group 1 being the most important. Only Group 1 buildings require both structural and nonstructural evaluations. Group 2 & 3 buildings require nonstructural evaluations only. Group 4 buildings require no further evaluations. The complete procedure is reprinted in Appendix C.

All Group 1 buildings proceed to a preliminary evaluation. The preliminary evaluation is based on ATC-22, but has been modified for the USPS. It includes the ATC-22 building checklists and rapid lateral force resisting system checks to identify structural deficiencies needing more investigation. The resulting report places the building in one of four categories: 1) acceptable, 2) in need of minor repairs, 3) has marginal capacity, or 4) needs major work. The last two categories require a detailed evaluation unless it is deemed that the building should be demolished or substantially changed.

The detailed evaluation contains provisions for a static analysis based on ATC-22 or a post-yield dynamic analysis for important buildings. It requires the consulting structural engineer to provide strengthening schemes and details, and cost estimates. Retrofit schemes for each class of building are detailed in ATC-26-4.

The nonstructural element bracing guidelines are based on ATC-22, but are expanded to include mail-processing and other specialized equipment for USPS. Most equipment is designed to a life-safety level except equipment deemed critical to the USPS which is designed to be fully functional. Extensive details for bracing equipment are provided in ATC-26-4.

Agency Issues

The Postal Service preferred the ATC-22 type approach to determine the life safety of a building as opposed to a scoring system for prelininary screening such as ATC-21 or GSA's DFA procedure. The problems they are currently dealing with include how to incorporate the UCBC provisions for unreinforced masonry buildings into ATC-26-1 and how to define requirements for buildings east of the Sierras. Most of the buildings in their initial study are in the greater San Francisco Bay Area and Southern California.

Reference Documents

Applied Technology Council, 1991. U.S. Postal Service Procedures for Seismic Evaluation of Existing Buildings (Interim). Applied Technology Council Report ATC-26-1, Redwood City, California.

Applied Technology Council, 1991. U.S. Postal Service Procedures for Postearthquake Safety Evaluation of Buildings (Interim). Applied Technology Council Report ATC-26-2, Redwood City, California.

Applied Technology Council, 1991. Field Manual: U.S. Postal Service Procedures for Postearthquake Safety Evaluation of Buildings (Interim). Applied Technology Council Report ATC-26-3, Redwood City, California.

Applied Technology Council, 1991. U.S. Postal Service Procedures for Seismic Retrofit of Existing Buildings (Interim). Applied Technology Council Report ATC-26-4, Redwood City, California.

2. U.S. General Services Administration, Public Buildings Service

Overview of Program

The General Services Administration's earthquake program was started in 1977 after passage of the NEHRP Act. The details of the program can be found in the Chapter 12 of GSA's building handbook entitled "Seismic Design Guidelines." The program includes procedures for rapid screening, detailed building evaluations and non-structural/equipment bracing. The program does not include preliminary building evaluations. GSA conducted the initial screening of most of its important buildings in 1987 and adopted model building codes for new construction in 1988. In addition, they have evaluated and strengthened a few facilities that were scheduled for extensive remodelling.

GSA plans to do seismic strengthening on those buildings first when recommended renovation is extensive enough to require a complete prospectus for approval by Congress. Prospectus level is set at $1.5 million or above. This is done as a single engineering phase approach following the recommendations of structural engineering consultants presented from the Building Evaluation Report (BER) Program, precursory to the development of the Prospectus Development Study (PDS). Generally, the cost of nonrecurring repairs of renovation projects, excluding seismic work, must also approach 50 percent of the building's replacement cost, before "full compliance" with GSA performance objectives will take effect. The performance objective for most GSA buildings is life-safety based on a minimum strength levels equivalent to 80% of the current (1991) UBC. Existing buildings designed to meet the 1976 UBC will be excluded from evaluation and any new building brought into the GSA inventory must meet this criteria as well. Leased buildings (more than 10,000 sq. ft. for partially leased buildings) in UBC zones 3 & 4 must be shown by their owner to comply fully with the 1976 UBC or be strengthened before the lease will be renewed by GSA. The 1976 UBC lateral force level is slightly higher than 80% of the current UBC code force level used for GSA owned facilities.

GSA's rapid screening procedure is called Decision Factor Analysis (DFA). It was written in 1977 and uses existing records and building drawings to achieve a quantified building score. The higher the score, the greater the seismic risk associated with the building. A building's score depends on a number of variables which are classified into four major groups. The seismicity factor "S" characterizes the expected and maximum credible events at the site and includes distance to faults, magnitude of expected ground motion, and intensity. The performance factor "P" defines the expected and desired level of performance of the structure in the seismic event and includes occupancy, construction type, structural configuration, economics, and existing condition. The building location factor "L" depends on characteristics of a particular site and includes site amplification and stability. The criteria confidence factor "C" relates to the seismic criteria applicable at the time of construction and includes lateral force and distribution used for design, construction details, and torsional effects.

The sum of all these factors (S+P+L+C) is equal to a maximum of 275 points with the distribution of total points being as follows: S_{max}=60 points, P_{max}=160 points, L_{max}=20 points, and C_{max}=35 points. The complete procedure is reprinted in Appendix E. The classification of risk for buildings in UBC zones 3 & 4 is: 175-275, serious risk; 100-174, significant risk; 99 or less, low risk.

The factors considered when selecting buildings for further evaluation include: 1) DFA over 175, 2) UBC zones 3 & 4, 3) hazardous building type, 4) hazardous soil conditions, and 5) greater than 3000 occupants. The procedure was recently tested on 20 GSA buildings in the San Francisco Bay area after the Loma Prieta earthquake of 1989. The study computed DFA scores for a number of buildings that were damaged to various degrees during the earthquake. It was shown that the correlation between DFA number and actual damage was good. Most of GSA's significant buildings have gone through this rapid screening procedure.

When seismic strengthening is required because of a proposed major building renovation, a detailed evaluation is performed by a consulting structural engineer. The building is evaluated for lateral forces of 80% of the current UBC code (1991). GSA requires that a number of strengthening solutions be explored in a detailed evaluation. A geotechnical engineering report and/or non-destructive material tests are required on a case-by-case basis. A "cost/benefit" type analysis is always performed. Development of the cost/benefit analysis technique is left to the consulting engineer.

The nonstructural guidelines are applicable to both new and existing GSA buildings. All equipment is anchored using the provisions of the current (1991) UBC code. Although few details are provided, extensive written guidance is given for most nonstructural elements and building contents in Chapter 12.

Agency Issues

GSA has seismically upgraded a number of buildings, based on the available funding Many agencies are concerned with added costs associated with a seismic renovation. A major cost is due to disruption of services. This cost can be incurred by relocating occupants or renting additional space if a building needs to be vacant during construction. The disruption costs are not included in cost estimates of GSA building retrofits since they come out of a different budget (Real Estate). GSA is actively pursuing base isolation as an alternative retrofit method. GSA is concerned with the large event potential in the Eastern United States not accounted for by normal zoning, but it currently does not have any special provisions for addressing this type of event.

Reference Documents

Daly, Leo A., 1989. Evaluation of the DFA Procedure for the Seismic Ranking of Buildings. Prepared for General Services Administration, San Francisco, California.

Daly, Leo A., 1989. Evaluation of the DFA Procedure for the Seismic Ranking of Buildings - Appendix A. Prepared for General Services Administration, San Francisco, California.

Howard, Duncan, 1987. Implementation of the GSA Seismic Safety Program. A memo to regional administrators, 25 November 1987, Washington D.C.

U.S. General Services Administration, 1990. Guide Specification: Special Seismic Protection and Inspection Requirements. supplement to MasterSpec, Washington D.C.

U.S. General Services Administration, Public Buildings Service, 1990. Facilities Standards for the Public Buildings Service, Chapter 12, Seismic Design Guidelines.
As amended.

3. Department of the Navy

Overview of Program

The Navy's seismic evaluation program was begun in early 1970. The procedure is detailed in NAVFAC P-355.2, "Seismic Design Guidelines for Upgrading Existing Facilities." It includes computerized rapid screening, preliminary and detailed building evaluations, retrofit procedures, and nonstructural bracing guidelines. Since the start of the program, approximately 14,000 buildings have been screened, with about 330 found to be deficient through detailed evaluations. The complex control of funding by sub-groups within the Navy, as well as competing priorities for limited available funds, has made it difficult to retrofit these structures. Most Navy buildings are only seismically upgraded when they are renovated. The Navy's program requires seismic strengthening whenever the cost of renovation exceeds $150,000 or 10% of the replacement cost of building, whichever is greater. To date, about 40 Navy buildings have been upgraded, with an additional 80 in planning at various Navy activities.

About 85% of the Navy's building inventory is intended to be strengthened to a life-safety level. The remaining 15% are considered to be mission-essential facilities which are intended to meet a fully functional performance objective. These essential facilities include: communication centers, power plants, weapons control, handling, storage facilities and hospitals.

The computerized rapid screening portion of the program eliminates a number of different categories of buildings. These include: buildings in UBC seismic zones 0, 1 & 2, one-story wood and preengineered metal buildings, one and two family housing units, buildings with areas less than 3000 sq. ft. (unless essential) and buildings scheduled to be replaced in the next 5 years.

The buildings identified for further study by the rapid screening process go through a preliminary evaluation based on the Navy's Rapid Seismic Analysis Procedure (RSAP). These procedures are outlined in Appendix D of P-355.2 and are usually conducted by a consulting structural engineer. An estimate of damage is achieved graphically by plotting points presenting the period of the building at first yield and building at ultimate and capacity on the site specific response spectra for 5% and 10% damping. This value is then scaled using the results from observed damage in previous earthquakes. A building with a damage percentage of over 60% usually initiates a detailed evaluation. Building damage percentages between 30% and 60% may cause a detailed evaluation and less than 30% is usually not evaluated unless it is an essential facility or unusual structural conditions exist. The complete procedure is reprinted in Appendix C.

The detailed evaluation, termed "detailed analysis" by the Navy, is also carried out by a consulting structural engineer based upon guidelines in NAVFAC MIL-HDBK 1190 and P-355.2. This procedure goes into more depth than the preliminary analysis and develops strengthening schemes and cost estimates. It has provisions for both a static lateral analysis and a quasi-dynamic analysis. There is a different procedure for each performance objective. Facilities being strengthened to a fully functional objective are strengthened to the degree feasible and practicable for assuring life-safety and continued post-earthquake operations. These facilities are reviewed using P-355.1, MD P-355.2, the guidelines for new essential buildings, using a quasi-dynamic analysis. Facilities being strengthened to a life-safety level are reviewed using P-355.2, the guidelines for existing buildings, using either a static or a quasi-dynamic analysis (Determined on a case-by-case basis).

Nonstructural component bracing guidelines are outlined in P-355.2, Chapter 9. This chapter includes general guidance for architectural elements and most types of equipment but not for building contents. More specific details are provided for plumbing lines and pipe support. Nonstructural concerns may be addressed in either the preliminary or the detailed analysis.

Agency Issues

The Navy intends to continue their seismic evaluation program and would also like to see a special fund set aside by Congress that could be used for strengthening projects. They are interested in these Guidelines for Federal Buildings but hope they are not required to re-evaluate all of their buildings. The big issues in their mind are: 1) the strength level at which a building is not acceptable and needs a seismic upgrade and 2) the new strength level at which the building will be acceptable.

Reference Documents

Departments of the Army, the Navy, and the Air Force, 1982. Seismic Design for Buildings. TM 5-809-10, NAVFAC P-355, AFM 88-3, Chap 13, Washington D.C.

Departments of the Army, the Navy, and the Air Force, 1986. Seismic Design Guidelines for Essential Buildings. TM 5-809-10-1, NAVFAC P-355.1, AFM 88-3, Chap 13, Sec A, Washington D.C.

Departments of the Army, the Navy, and the Air Force, 1988. Seismic Design Guidelines for Upgrading Existing Buildings. TM 5-809-10-2, NAVFAC P-355.2, AFM 88-3, Chap 13, Sec B, Washington D.C.

Department of the Navy. Facility Planning and Design Guide. Chapter 6, MIL-HDBK-1190, Washington D.C.

4. Department of Veterans Affairs

Overview of Program

After the 1971 San Fernando earthquake in Southern California, the Department of Veterans Affairs began a program of evaluating and upgrading their hospital and medical facilities as mandated and funded by Congress. In 1973, the VA formed a Structural and Fire Safety Committee and in 1975, it completed and began using H-08-8, the VA's seismic design guidelines. These seismic guidelines have been stricter than the hospital industry. Expected peak ground acceleration (PGA) is used as a seismicity index instead of zone. The VA program does not include rapid screening but outlines Phase I (preliminary) and Phase II (detailed) building evaluations.

After site-specific studies were conducted in the 1970's, 49 of the VA's 172 medical sites nationwide were pinpointed as seismically vulnerable. Of the 301 buildings originally found as deficient, 117 have been strengthened.

The primary trigger to seismic strengthening is planned renovation or remodel of more than 40% to 50% of the replacement building cost. The VA has two performance objective levels. It expects hospitals to be fully functional after an earthquake and non-bed medical facilities to be life-safe. The VA's first priority are buildings in seismic zones with peak ground acceleration (PGA) greater than .25g, regardless of use. The next priority is patient bed buildings in zones with PGA between .15g and .25g. The lowest priority are bed buildings in zones with PGA less than .15g and non-bed buildings in zones with PGA less than .25g. The VA leases some out-patient clinics and requires that these facilities meet seismic standards equal to 80% of the current UBC code. The buildings the VA is concentrating on are located primarily in UBC Zones 2A, 2B, 3 and 4.

When a site is identified as vulnerable, Phase I evaluations are conducted on all buildings at the site. Both the Phase I and the Phase II evaluations are performed by consulting structural engineers. The Phase I evaluation identifies the seismic capability of the building and checks conformance to the H-08-8 code. The evaluation results in one of three outcomes: 1) conformance, 2) non-conformance and correction needed, and 3) non-conformance and immediate correction or evacuation needed.

Phase II evaluations are conducted on all buildings that are not in conformance with the H-08-8 code and need some correction. The Phase II evaluation investigates different strengthening schemes and develops cost estimates for each system. Nonstructural equipment bracing is handled by the mechanical branch of the VA design team and is mainly based on local codes.

Agency Issues

The VA remarked that when it was introduced, H-08-8 was much more stringent than the 1970 UBC. But over the years, the UBC has gradually approached the force levels required by H-08-8 although the VA drift requirements remain more stringent. The VA thought there needed to be rational procedures for determining the percent of current code acceptable for upgrading existing buildings. They also mentioned life expectancy of the building as a key issue, as well as trying to deal with the new information related to the seismicity of the eastern part of the United States.

Reference Documents

Veterans Administration, 1986, Seismic Design Guidelines. Veterans Administration Seismic Design Guidelines H-08-8, Washington D.C.

Veterans Administration, 1986, Seismic Design Guidelines - Site Evaluation Survey for Existing Facilities. Veterans Administration Seismic Design Guidelines H-08-8, Appendix A, Washington D.C.

Veterans Administration, 1986, Seismic Design Guidelines - Scope of Work for Phase I and Phase II Evaluations of Existing Facilities. Veterans Administration Seismic Design Guidelines H-08-8, Appendix B, Washington D.C.

5. Department of State - Foreign Building Office

Overview of Program

The Department of State's Office of Foreign Buildings is the landlord for over 256 posts world-wide encompassing more than 8000 buildings. These buildings include embassies, consulates, motor pools, storage buildings and a large inventory of housing. About one-third of the buildings are owned, one-third long-term leased (>10 years) and one-third short-term leased (<10 years). All of FBO's retrofit projects are connected with a major facility renovation of which seismic is one of many concerns. The decision to retrofit is based on a qualitative judgement tailored to the unique characteristics of each project. FBO considers a large number of influencing factors including: seismicity, value of the building, master planning, concerns and input of the Post, evidence of existing structural distress, change in building use and changes in Post programs. Worldwide seismicity factors are based on a report by Woodward-Clyde unless further study dictates otherwise.

The Phase I and Phase II scopes of work are similar to those of VA. Phase I identifies the seismic capability of the building and Phase II investigates strengthening schemes and related costs. The FBO program is handled mostly by contracted structural consultants who perform Phase I and Phase II evaluations on a case by case basis. The degree of risk for any particular building is determined by the consulting structural engineer based on their judgement and the standard of practice.

Agency Issues

Because FBO deals with buildings outside the United States, it must look at individual sites and compare the local determination of seismic risk with that of the U.S. In some instances, as in Canada, local codes are more stringent. Also, the FBO has many influencing factors such as changes in Post programs and changes in building use which are not under its control and make it difficult to implement and maintain any program.

6. Department of Energy

Overview of Program

The Department of Energy (DOE) has had a long history in the earthquake hazard mitigation field dating back to the first commercial nuclear reactors. Their main guidelines for non-reactor facilities, UCRL-15910, were written by Lawrence Livermore National Laboratory (LLNL) in 1985 and updated in 1990. In addition, DOE has sponsored seismological investigations and developed site-specific ground accelerations at each site, and published the results in UCRL-53582. The program is centered around the "Safety Analysis Report" which is updated every 5 years at all DOE sites for all structures. It includes information on criteria used for the original building design, accidents that could occur, mitigation strategies for all natural phenomena hazards, and how the structure compares to current design requirements.

DOE has four performance objective levels (general use, important or low hazard, moderate hazard, or high hazard) depending on the nuclear, chemical, or classified nature of the building's use. Moderate or high hazard buildings are governed by UCRL 15910 and would not be covered by our guidelines. Low hazard facilities are treated as essential facilities with the current UBC code. General use buildings are

treated as general facilities with the current UBC code. The program calls for all general use buildings to be 100% in compliance with the current UBC code using an annual probability of exceedance of 10^{-3} of the onset of significant facility damage. The same applies for low hazard facilities, except that the importance factor "I" increases to 1.25, using UBC terminology. This corresponds an annual probability of exceedance of $5x10^{-4}$ of facility damage to the extent that the facility cannot perform its function. Most of DOE's office space is leased through GSA.

DOE currently has an evaluation program for existing general use or low hazard buildings. To date, they have concentrated most of their seismic retrofit construction dollars on moderate or high hazard facilities. LLNL has developed documents for equipment bracing. These guidelines have also been applied to other DOE facilities.

Agency Issues

DOE had a number of comments about what they wanted from the Guidelines for Federal Buildings. They thought it was important to have detailing requirements for new and existing buildings to cover their "normal" low hazard buildings. They also were interested in efficient evaluation methods for older DOE buildings. They thought that the resulting performance criteria should address the useful life of the building and that this should be consistent among agencies. If all of the agencies were using the same rules, it would help DOE to deal with buildings leased from GSA (Oak Ridge, TN for example).

Reference Documents

Lawrence Livermore National Laboratory, 1990. Workshop on the Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards. conference on UCRL-15910 in Peabody, Mass., June 4-7, 1990, Washington D.C

United States Department of Energy, 1990. Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards. Department of Energy UCRL-15910, Washington D.C.

7. Department of Transportation - Coast Guard

Overview of Program

The Department of Transportation (DOT) started developing seismic guidelines shortly after the passage of the NEHR Act in 1977. The DOT includes the Federal Aviation Administration, Federal Highway Administration, Federal Railroad Administration, National Highway Transportation Safety Administration, and the Saint Lawrence Seaway, and their largest building owner, the U.S. Coast Guard. The Coast Guard program includes requirements for new construction and a rapid screening procedure, but has not yet developed more detailed evaluations or nonstructural bracing guidelines. Currently they have screened 16,000 buildings nationwide and identified and ranked the 974 most hazardous facilities. They are in the process of refining their rapid analysis to look at the 100 highest ranked buildings. Currently, two buildings at the Alameda facility are in the process of being rehabilitated as they were scheduled for renovation. The detailed evaluations were conducted by a local A/E firm.

The FAA has been performing seismic evaluations of their facilities for a number of years. The Coast Guard's rapid analysis procedure is based on a modified FAA model developed for the FAA by the Transportation Systems Center in Cambridge, Massachusetts. It weights five parameters (in order of decreasing weight): frame type (URM, RM, URC, RC, steel, wood), seismic zone (1-7), number of staff (0-100+), age of building (<1945-1982>), and importance (1-4). The refined screening will expand the building types based on the ATC-14/22 building types. The Coast Guard has looked at its facilities and has put them in 4 importance categories. Category 1 is their "essential", building category, and includes communication centers, Loran-C radar buildings, and aircraft hangers It is intended that these buildings be fully functional after a design level earthquake. Their other three categories require a life-safety performance level. The following facilities are not included in the Coast Guard screening: wood-framed single-family housing, lighthouses, low-importance storage buildings, fuel tanks, transmission towers, and exposed emergency generators. The complete procedure is reprinted in Appendix C.

Agency Issues

Since the Coast Guard has not yet really started the detailed evaluation stage of their program, they seemed very open to suggestions.

Reference Documents

Lebofsky, D., 1991. MEMO: Seismic Risk Assessment. 15 November 1991 memo from Chief of Civil Engineering Division, U.S. Coast Guard, Washington D.C.

United States Coast Guard. Manual of Construction - Chapter 10: Design Policy. Washington D.C.

United States Department of Transportation, Transportation Systems Center, 1988. FAA Seismic Risk Assessment. Documentation on Version 1.1 of program to rapid screen buildings for the FAA, Cambridge, MA.

B. Private Sector Organizations

1. Hewlett-Packard

Overview of Program

Hewlett-Packard started developing a comprehensive seismic mitigation program in the late 1980's. The program was intended to address the safety of all HP employees and also the ability of HP facilities to be functional as soon as possible after a major earthquake. The program includes a screening procedure, preliminary and detailed building evaluations, and nonstructural guidelines and details. To date, a pilot program studying 141 of their over 800 buildings has been completed. HP has now expanded their program to investigate all HP facilities worldwide.

The main performance goals of the HP program are life-safety and repair time. The life safety level seismic strengthening is defined by ATC-14. HP has defined repair time in terms of three categories of time required to occupy the building after a major earthquake: 1) less than two weeks, 2) 60 to 90 days, and 3) 90 days or more. For more important facilities, and for all retrofit projects, HP uses its guidelines for new construction which outlines three performance categories: "Category A" for immediate occupancy based on UBC with an I=1.5 with restrictions on configuration, type of framing system, and allowable story drift, "Category B" for repairable damage based on the current UBC code with restrictions on framing type and irregularities, and "Category C" for repairable damage based on the current UBC.

The HP rapid screening is based on the importance to HP operations, seismicity, and proximity to HP headquarters in Palo Alto, California.

The preliminary evaluation is based on the ATC-14 checklist, amended for Hewlett-Packard. The checklist is the same as the ATC-14 version, except that, in addition, the consulting structural engineer performing the evaluation makes a determination of the severity of the life-safety hazard of the building (high, moderate, low) and the level of damage expected in terms of repair time (occupiable within 2 weeks, 60-90 days or more than 90 days). The checklists are accompanied by copies of portions of the building drawings, photographs from the building walkthrough, and results of a Probable Maximum Loss (PML) analysis. After all the buildings are evaluated, they are ranked once according to life safety and once according to damage potential. The life safety ranking is obtained by sorting (in descending order): seismicity, life safety level, and maximum occupancy. The damage potential ranking is obtained by sorting by (in descending order): seismicity, damage potential (1,2 or 3), importance, and PML times floor area. The highest ranking buildings are selected for detailed evaluations.

The detailed evaluation addresses the deficiencies found in the preliminary analysis, develops strengthening schemes, and performs cost analyses. The schemes are developed related to a particular performance objective. Collateral hazards are usually addressed in a detailed evaluation. These evaluations are always performed by a consulting structural engineer.

The nonstructural bracing program is independent of the building evaluation program. All facilities are investigated for nonstructural hazards using the ATC-14 checklist. Included are: partitions, furring, ceilings, light fixtures, mechanical and electrical equipment, piping, ducts, elevators, cladding and veneer, parapets and cornices, and means of egress. In addition, a large number of typical details have been provided in HP's "Seismic Guidelines for Restraint of Nonstructural Components" which includes the SMACNA guidelines in full.

Reference Documents

Applied Technology Council, 1986. Methods for Evaluating the Seismic Strength of Existing Buildings. Applied Technology Council Report ATC-14, Redwood City, California.

H.J. Degenkolb Associates, Engineers, 1989. Hewlett-Packard Corporate Seismic Policy Development, Phase II. San Francisco, California.

Hewlett-Packard Company, 1990. Seismic Guidelines for New Construction. San Francisco, California.

Hewlett-Packard Company, 1990. Seismic Guidelines for Restraint of Nonstructural Components. San Francisco, California.

2. Kaiser Foundation Health Plan

Overview of Program

The Northern California Region of the Kaiser Permanente Medical Plan (Kaiser) began developing a comprehensive seismic program in 1973. The program was intended to insure the continued functionality of all Kaiser hospital facilities after an earthquake and a minimum of providing life safety in all buildings owned by Kaiser. The program includes a screening procedure, preliminary and detailed building evaluations, and nonstructural guidelines and details. To date, preliminary evaluations have been conducted on all 220 Kaiser-owned facilities. Detailed studies, including the development of strengthening schemes, have been conducted for all buildings with life-safety concerns.

Kaiser has identified three performance objective levels. The first performance objective is fully functional based on 100% of Title 24, the State of California, California Administrative Code. The next performance level is repairable damage based on 100% of current UBC code. The lowest performance objective is life-safety based on 100% of ATC-14 lateral force levels. Leased buildings have not yet been addressed in the Kaiser program.

The screening procedure consisted of sorting the database of buildings and removing all buildings scheduled for replacement and all leased buildings from further consideration.

The preliminary evaluation is based on completion of the appropriate ATC-14 checklist. The consulting structural engineer performing the evaluation makes a determination on the life-safety hazard of the building (hazard or no hazard). A detailed analysis is required for all buildings which do not obtain positive answers to all statements in the ATC-14 checklist.

The detailed evaluation addresses the potential deficiencies found in the preliminary analysis and, where required, develops strengthening schemes. The schemes are developed for two levels of strengthening; an ATC-14 lateral force level, and the current applicable code force level, Title 24 for hospital buildings and UBC for all other structures. In addition, cost estimates are performed on both schemes and a Probable Maximum Loss (PML) analysis is included. Specific strengthening levels and schemes are selected based on the regions' goals and a detailed economic analysis that considers strengthening costs, disruption costs during construction, expected earthquake damage and repair costs, and post-earthquake disruption costs. These evaluations are always performed by a consulting structural engineer.

A nonstructural bracing program is independent of the building evaluation program. All facilities are investigated for nonstructural hazards using the ATC-14 checklist. Included are: partitions, furring, ceilings, light fixtures, mechanical and electrical equipment, piping, ducts, elevators, cladding and veneer, parapets and cornices, and means of egress. A number of typical details have been developed for Kaiser by their consultants. Kaiser is conducting a building contents bracing program internally.

Reference Documents

Applied Technology Council, 1986. Methods for Evaluating the Seismic Strength of Existing Buildings. Applied Technology Council Report ATC-14, Redwood City, California.

3. Stanford University

Overview of Program

With its proximity to the San Andreas and Hayward faults, Facilities Project Management at Stanford University has implemented a program of evaluating and strengthening campus buildings. The Stanford program establishes performance goals for the facilities based on their function and includes preliminary building evaluations and detailed analysis procedures.

Stanford University has developed three levels of performance for their facilities, Class A, fully functional, Class B, damage control, and Class C, life safety.

For a Class A facility, the performance objective is to maintain occupant safety, remain fully functional, and confine hazardous materials. Downtime is limited to one day. The design load level is approximately the current UBC with an importance factor of 1.5. Equivalent static or dynamic analysis are acceptable methods of evaluation. Fire and police stations are buildings typical of this category.

Class B facilities are to be designed to limit damage to be compatible with the prescribed downtime of 2 weeks. The load level is established using the UBC with modifications.

The performance objective of Class C facilities is to ensure occupant safety. Downtime is 3 months to 2 years. Design guidelines for Class C URM Buildings is in accordance with Chapter III Division C3 of the County of Santa Clara Ordinance Number NS1100.78 with modifications.

In addition to these guidelines, Stanford University has established a peer review panel as part of a Quality Control program. The panel consists of three independent engineers plus the Manager of Seismic Risk at Facilities Project Management. All classes of buildings are subject to the peer review.

For the preliminary evaluation, Stanford surveyed approximately 280 buildings. The evaluations consisted of a walk-through by a structural engineer. The buildings were rated on a scale of 0 to 10 on predicted performance during a magnitude 7.0 earthquake on the San Andreas fault, four miles to the west of the campus. Building performance improves with an increase in rating. Buildings with a rating of 6.0 to 7.0 were considered to have a design level that was average with respect to the 1976 UBC. From the survey, about 60 structures were identified as requiring strengthening.

Guidelines for strengthening of nonstructural elements and equipment are non-specific. Generally, strengthening of non-structural elements and equipment is to be consistent with strengthening requirements of the building. Reliance upon the engineer's judgement is used when identifying elements for strengthening. Strengthening is to be performed to industry standards. For some facilities, such as chemistry laboratories, the evaluation of non-structural systems is under the guidance of the Department of Health and Safety. In these instances, the guidelines generally exceed seismic strengthening.

Reference Documents

Stanford University, Facilities Project Management. Design Guidelines for Class A, B, C Buildings.

Bendimerad, F. M. and Shah, H. C., Stanford University. Development of Risk-Balanced Design Guidelines for the Retrofit of Existing Buildings.

4. Rocketdyne

Overview of Program

Rocketdyne is a division of Rockwell International and is involved in the manufacture of aerospace components. Rocketdyne is located in the Los Angeles basin and has approximately 40 buildings in its inventory. The use of these buildings includes offices, manufacturing and fabrication plants and laboratory spaces. Buildings are typically two to three stories high and may be as large as 200 ft. by 300 ft. in plan. Construction types include tilt up, cast-in-place concrete frames and walls, braced frames and moment frames. Because of the seismicity of the area, these buildings were included in a corporate survey of approximately 200 Rockwell International buildings. While various divisions of Rockwell are attempting to address the issue of seismic strengthening, Rocketdyne is the only division with a formal program in place. Rocketdyne's seismic program includes rapid screening, detailed evaluation, and non-structural guidelines.

Rocketdyne has defined four importance categories for their facilities, Category A, very high importance, Category B, high importance, Category C, Low importance, Category D, lowest importance. The performance goal of a particular facility is based on its importance. For example, Rocketdyne's performance objective for a very high importance facility includes no loss of facility use during a low level earthquake, minor structural damage in a moderate earthquake and repairable structural damage (within days) with limited shutdowns for a maximum credible earthquake. Similar performance objectives are established for the other importance categories.

The initial survey, which can be viewed as a rapid screening analysis, enabled Rocketdyne to categorize the buildings in terms of seismic risk. The rapid analysis procedure consisted of a walkthrough by an engineering consultant selected by Rocketdyne. Based on experience and judgement and a knowledge of the building's function, the consultant rated the buildings and placed them into only four categories. The buildings were categorized as being either very high, high, medium or low seismic risk. The consultant observed the lateral force system, the construction type, and noted the building's age.

While Rocketdyne may conduct further reviews of buildings in the low, medium and high categories, efforts to date have been focused on the most very high risk buildings. This approach is necessitated by the prohibitive cost of analyzing all buildings. The very high risk buildings are being evaluated by a detailed analysis procedure developed by Rocketdyne.

Rocketdyne's procedure uses a modification of the Tri-Services manual. Buildings are evaluated using site specific spectra for a low level earthquake (75 year recurrence interval), an upper level earthquake (475 year), and a maximum credible earthquake (2475 year). An elastic dynamic analysis is performed and the concept of an "inelastic demand ratio" is used to describe the ability of the elements to resist calculated stresses that exceed those at yield. Based on the Tri-Services Manual, Rocketdyne has established permitted inelastic demand ratios for each earthquake level. These ratios may be reduced by a factor to account for elements in existing structures which would not meet the ductility assumed by the ratio. After calculating the D/C ratios for all elements, the ratios are ranked to establish a hierarchy of vulnerabilities. This hierarchy helps to determine the performance rank of the building.

Damage from previous earthquakes, exterior falling hazards, and the effect of adjacent buildings are considered in the detailed evaluation. In addition, collateral hazards, such as fault rupture, liquefaction, and landslides are also addressed. Strengthening schemes are included as part of a detailed evaluation. For any particular scheme, an estimation of damage in future events is made. Rocketdyne has established "Cost Avoidance Factors" which predict the percentage of loss due to building damage, contents losses, and business losses. The cost avoidance factors are used for cost-benefit analyses.

Rocketdyne is implementing an equipment bracing program separately from the structural program. Rocketdyne maintains a small in-house engineering staff which has been designing and implementing strengthening procedures for its equipment and furniture. The site specific spectra is used to establish force levels. Equipment strengthening force levels are typically 0.5 g and higher. While some standards are being developed, in most instances it is necessary to provide unique solutions.

Reference Documents

Nester, M. Russell, Rocketdyne, Porush, Allan R., Dames & Moore. A Rational System for Earthquake Risk Management.

IV PERFORMANCE OBJECTIVES

A performance objective is a qualified level of seismic performance that an owner expects of a structure. Typical performance objectives include life-safety, repairable damage, immediate occupancy or fully functional. To be effective, these objectives must take into account all pertinent factors such as structural framing type, site seismicity, and lateral force resisting system, details, etc. Cost limitations often make it impractical to design buildings to withstand a major earthquake with no damage. Performance objectives then, are a tool to use to make the most of available resources. The most essential buildings are designed or retrofit to higher standards than less important buildings. The minimum objective for all buildings should be life-safety.

There is no one definition of life-safety. Most would agree however that a building damaged to the point that could cause the death of occupants would be a life-safety concern during a major earthquake. From this definition, the main goals of life-safety would be to prevent collapse and falling hazards that would endanger someone's life. ATC-14 adds the following to the above definition: a building is deemed not life-safe if it is damaged enough to cause injury serious enough to prevent the occupants from exiting the building, or blockage of the exit routes thereby preventing the safe evacuation and/or rescue of the occupants.

Typically, existing building evaluation and strengthening standards are less than the standard set by current building codes for new facilities. Many buildings that will pass such a "life-safety" evaluation standard will not conform to current code requirements. Buildings which just pass life-safety criteria may not by usable immediately after a moderate or larger earthquake, and repairs may not be economically feasible. Strengthening schemes developed using life-safety criteria are often much less extensive and expensive than would be required for full compliance with current code requirements.

A performance objective above life-safety would be repairable damage. The evaluation of buildings for this level of performance after an earthquake is often based on the provisions for new buildings in regions of higher seismicity. Modern design provisions for new buildings such as the SEAOC "Blue Book" require greater lateral strengths, include building lateral force resisting system requirements and limitations, and include more extended detailing requirements than older codes. Typically, all elements that are found to not comply with the provisions are considered in relationship to the functionality and reparability of the building.

The highest performance objective is fully functional. This objective is usually reserved for critical facilities such as hospitals, fire and police stations, and communication centers that need to remain operational immediately after a major earthquake . The evaluation of critical facilities typically follows the provisions used if the building were new. These existing important facilities must adhere to the most stringent of today's standards such as Title 24, VA's H-08-8, DOE or P-355.1 in order to perform as well as recently constructed critical facilities.

The decision to strengthen a deficient building to a life-safety or a higher performance objective requires consideration of the cost of the strengthening, the disruption costs associated with the construction, as well as the level of safety and improved performance achieved under each solution. There is presently no consensus as to which buildings should be strengthened.

The following sections identify the performance objectives of the State of California Program and the federal agencies and private sector organization programs which were studied in depth in this study. A comparison between various agencies clearly indicates that while each of the programs are set-up and implemented differently, the performance objectives and goals are strikingly similar. A summary of the comparisons are presented in Tables 4 and 5, which are patterned after the format of the State of California Program, which is included in Table 3.

A. State of California Policy and Performance Objectives

The State of California has been concerned with the seismic performance of existing state-owned buildings for many years. The most visible plan was probably that developed by the University of California system in 1976. Until recently however, the State of California has not had a unified approach to address the large number of vulnerable buildings it owns. In 1991, the State of California Seismic Safety Commission published SSC 91-1, "Policy on Acceptable Levels of Earthquake Risk in State Buildings". It is the first Seismic Safety Commission document to attempt to define levels of acceptable seismic risk for buildings with various occupancy types. The State of California stated its objective as:

> The goal of this policy is that all state government buildings shall withstand earthquakes to the extent that collapse is precluded, occupants can exit safely, and functions can be resumed or relocated in a timely manner consistent with the need for services after earthquakes. Compliance with this policy will provide reasonable protection of life, but it will not prevent all losses of life, building function or damage.(SSC 91-1)

SSC 91-1 outlines six performance objective levels for existing buildings, each with a corresponding strengthening criteria. Within each level are 8 types of building occupancy. This creates an 8 x 6 matrix on which to plot minimum acceptable, acceptable, and not acceptable earthquake performance objectives. The performance objectives are: fully functional based on NRC standards, immediate occupancy based on Title 24, repairable damage based on current UBC, substantial life-safety based on 75% of 1988 UBC, ATC-14, ATC-22, or 1976 UBC, life hazards reduced based on UCBC, and very poor life safety. The occupancy categories are: hospitals and essential services, hazardous materials, public schools, nursing homes and prisons, offices and courts, other, and historic buildings. The full matrix is reproduced in Table 3.

B. Government Agencies

1. U.S. Postal Service

The primary performance objective for existing USPS facilities is life-safety based on a minimum of 80% of the current NEHRP provisions for new buildings lateral forces, based on the ATC-22 evaluation system. Facilities deemed essential to the operation of USPS may be designed for a more stringent requirement. Currently, the documentation in ATC-26 does not identify these critical facilities nor to what greater level they should be strengthened. Currently, the USPS is evaluating the applicability of the UCBC provisions for retrofit of unreinforced masonry buildings. The USPS uses the same performance objectives for both existing owned and leased buildings.

2. General Services Administration, Public Building Service

The primary performance objective for most GSA buildings is life-safety based on a minimum of 80% of the current UBC code. GSA currently has not identified any critical facilities that need to be strengthened to a higher level than life-safety. Leased buildings (more than 10,000 sq. ft. for partially leased buildings) in UBC zones 3 & 4 must be shown by their owner to comply fully with the 1976 UBC or be retrofit before the lease will be renewed by GSA.

3. Department of the Navy

The Navy has two performance objective levels. The performance objective for about 85% of Navy buildings is life-safety based on 100% of NAVFAC P-355.2, the Navy's guidelines for upgrades of existing buildings. The objective for the remaining 15% is to remain fully functional based on 100% of NAVFAC P-355.1, the Navy's guidelines for new construction of essential facilities. These critical facilities include: communication centers, power plants, weapons control, handling, and storage facilities and hospitals. The essential facilities are evaluated using a quasi-dynamic procedure based on a 10% chance of exceedence in 100-year spectrum. The life-safety buildings, as a minimum, are evaluated using a static analysis meeting NAVFAC P-355, which is based on the SEAOC Provisions (10% chance of exceedance in 50-year spectrum).

4. Department of Veterans Affairs

The VA has two performance objective levels. The performance objective for its hospital facilities is to remain fully functional based on 80% to 85% of H-08-8, the VA's seismic code for new construction. The performance objective for its non-bed medical facilities is life-safety based on 100% of the current UBC Code. The VA's first priority are bed and non-bed buildings in seismic zones with PGA greater than .25g. The next priority is bed buildings in zones with PGA between .15g and .25g. The lowest priority are bed buildings in zones with PGA less than .15g and non-bed buildings in zones with PGA less than .25g. The VA leases some out-patient clinics and expects these facilities to be at the 80% or greater level of the current UBC code.

5. Department of State - FBO

The basic performance objective for FBO is life-safety although other performance levels could be required on a case-by-case basis. The life-safety objective is based on a percentage of the current UBC code dependent on available data on site seismicity. In addition, for both new and existing buildings, local codes are considered, and may control, since some regions of the world have more stringent requirements than the UBC. For the existing building situation, strengthening to a local code with more stringent requirements than the UBC would only occur under unique circumstances. A large number of FBO buildings are leased. Some leased buildings have been evaluated but few strengthened as they are a lower priority. Leased buildings are subject to the same strength criteria as owned buildings, but many times the building being leased is the best available building in that region.

6. Department of Energy

The Department of Energy has four performance objective levels, one for each classification of its buildings: high hazard, moderate hazard, low hazard, and general use. These categories reflect the need for confinement of contents to protect the public and the environment. The performance objective for high hazard buildings is fully functional based on UCRL-15910. The performance objective for moderate hazard buildings is between fully functional and repairable damage, and is similar to high risk category of DOD Tri-Service Manual for Seismic Design of Essential Buildings. The Guidelines for Federal Buildings are not intended to focus on either of these types of buildings. The performance objective for low hazard buildings is repairable damage based on 100% of the current UBC code using a importance factor of 1.25 for "essential" buildings. The performance objective for general use buildings is life-safety based on 100% of current UBC code. Most of DOE's leased buildings are controlled by GSA.

7. Department of Transportation - Coast Guard

The Coast Guard has two performance objective levels. The performance objective for its "Category 1" buildings is fully functional. The performance objective for its "Category 2,3 & 4" buildings is life-safety. Category 1 includes essential facilities such as communication centers, Loran-C radar buildings, and aircraft hangers. The Coast Guard has not yet set a level of strengthening to their either of their performance objective levels.

C. Private Sector Organizations

1. Hewlett-Packard

The main performance objective of the HP program is life-safety based on 100% of the lateral force level defined by ATC-14. The other important objective is damage potential. HP has defined damage potential using three categories of time to occupy the building after a major earthquake: 1) less than two weeks, 2) 60 to 90 days, and 3) 90 days or more. The damage potential is estimated by the engineer conducting the preliminary building evaluation. For more important facilities, those key to HP's business efforts, and for all retrofit projects, HP uses its standards for new construction which outlines three performance categories: "Category A" for immediate occupancy based on Title 24, "Category B" for repairable damage based on the current UBC code with restrictions on framing type and building irregularities, and "Category C" for repairable damage based on the current UBC.

2. Kaiser Foundation Health Plan

Kaiser has three performance objective levels. The performance objective for hospital buildings is fully functional based on 100% of Title 24, the State of California, California Administrative Code. The performance level for important medical office buildings is repairable damage based on 100% of current UBC code. The performance objective for other medical office buildings as well as support facilities is life-safety based on 100% of ATC-14 lateral force levels. Leased buildings have not yet been specifically addressed in the Kaiser program, though they will be judged in a manner consistent with the owned facilities.

3. Stanford University

Stanford has developed three performance objective levels. The performance objective for its "Class A" buildings such as fire and police stations is fully functional based on current UBC code with an importance factor I=1.5 (equivalent to Title 24). The performance objective for its "Class B" buildings is repairable damage based on the current UBC code. The performance objective for its "Class C" buildings, typically URM buildings, is life-safety based on the UBC with a maximum base shear of 0.13g, or the UCBC provisions.

4. Rocketdyne

Rocketdyne has identified twelve performance objective levels based on the importance of the facility to the company operation and the seismicity of the site. Because facilities are evaluated for three levels of earthquakes, Rocketdyne has established a matrix of building performance for each design level event: 75 year return period, 475 year return period, and 2475 year return period. An expected performance goal ranging from superficial damage to life-safety is given for each building category at each earthquake level.

V A REVIEW OF ATC-28 FOR APPLICABILITY TO THE GUIDELINES FOR FEDERAL BUILDINGS

The main purposes of an issue by issue review of ATC-28 are, first, to utilize this thorough identification and resolution of strengthening issues to assure that the guidelines for federal buildings will be adequate, and, by extension, to identify the applicability of the final FEMA strengthening guidelines to federal buildings. This analysis will help guide the development of the Guidelines for Federal Buildings and identify areas that may need special consideration pending completion of the FEMA guideline development program.

ATC-28 and the proposed FEMA Guidelines are directed at seismic strengthening only. The Guidelines for Federal Buildings, which will describe a general policy and standards to reduce seismic hazards from existing federal buildings, will include preliminary evaluation, detailed analysis, strengthening, and implementation guidelines. ATC-28 issues will, therefore, at best, be applicable to and address only the strengthening portion of the federal document.

Each issue in ATC-28 can be grouped into those which deal with the FEMA writing/development process and those which deal with the final scope and contents of the guidelines. The process issues are, in general, not applicable to the Guidelines for Federal Buildings because of the basic difference in the development scope and schedule. For example, development of new technical material is not foreseen for the Federal document, whereas several areas of significant development are clearly required for the FEMA Guidelines. In addition, the FEMA Guidelines are intended to have the broadest application possible, to encourage and control seismic strengthening in both mandated formal programs and in the context of voluntary self-improvement; the Guidelines for Federal Buildings are expected to be used in the narrower context of a unified policy.

A review of ATC-28 would indicate that the majority of issues (those that do not apply to process) will generally be applicable to strengthening guidelines for federal buildings. However, the discussion and resolution of the issues contained in ATC-28 also indicate areas where additional policies will be needed to successfully implement strengthening guidelines. For example, the resolution of several issues is suggested to be left to the "local jurisdiction". In the case of a federal seismic strengthening program, which will, in most cases, have no local counterpart, the federal government will have to provide the required guidance. In other cases, as mentioned above, important aspects of an overall strengthening program are suggested not to be within the scope of the FEMA document; the most obvious and important example is the determination of when strengthening will be required, which may include "triggering" situations and/or a time schedule. For realistic and effective reduction of the hazard in federal buildings, this is the most important aspect of a guideline.

In this analysis, each ATC-28 **issue** will be classified as follows:

> **Applicable**: The issue is applicable to strengthening of federal buildings.
>
> **Not applicable**: The issue is not applicable to the Guidelines for Federal Buildings because it refers to the process of development or because the characteristics of the federal inventory or administrative process eliminates the issue from consideration.

In addition, for applicable issues, the adequacy of the suggested **resolution** of the issue will be judged. Each resolution will be classified as follows:

> **Applicable and adequate**: These resolutions are judged to apply to federal buildings. Conventional methodologies or practices exist that are relatively consistent with the recommendation.
>
> **Applicable but requires significant technical development**: These resolutions are judged to apply to federal buildings but will require significant technical development to become viable. No parallel simplified guideline or procedure exists.
>
> Until a simplified procedure is developed (in the FEMA Guidelines or elsewhere) these design issues must be treated on an individual basis using engineering judgement, as is currently being done. The downside of this practice is that the performance of the mitigation measures will be inconsistent and, since individual engineers will tend to be conservative, the mitigation may be excessively costly.

Not applicable: These resolutions are judged not to be applicable to federal buildings and the issue will require the development of additional policy or documentation for resolution.

The completed Guidelines for Federal Buildings must contain appropriate policy or references to resolve these issues. The detail of these resolutions will be developed with the Guidelines.

A complete list of ATC-28 issues follows, along with a classification for both the issue and the resolution proposed in ATC-28. A note of explanation is included for entries of "not applicable", and other selected entries as appropriate.

2. *Issues of Scope*

2.1 **Definition of "Building":** The Guidelines are limited in scope to buildings, but what is the precise definition of this term?

ATC-28 Resolution: The 1988 NEHRP chapter 1 description should be the starting point of the definition of "building", but without excluding single family dwellings in certain seismic zones. Also, the Guidelines writers should not feel compelled to develop specific provisions for the UBC's descriptions of other structures such as elevated tanks or billboards, except for components that are commonly a part of a building.

Issue: Applicable

Resolution: Applicable and adequate

2.2 **Determination of Applicability:** Should the Guidelines include provisions for "triggers" that would specify whether a given building is subject to the provisions and according to a particular priority?

ATC-28 Resolution: Provisions for triggers that specify when the Guidelines will be applicable should not be included in the Guidelines. How the building comes to appear on a list of buildings requiring seismic strengthening, or to be subject of a voluntary upgrading, is irrelevant to the task of writing a guide describing how to strengthen that building. The trigger decision is really a combination of building

evaluation and local political and technical judgement. Even if applicability rules were included within the Guidelines, they would probably be quickly deleted when the Guidelines are adapted to serve as a standard or code regulation.

Issue: Applicable

Resolution: Not Applicable

Note: Descriptions of circumstances under which buildings must be strengthened, or scheduled mandated programs are not within the scope of ATC-28. This is the most important aspect of a federal document and such an administrative program must be developed.

2.3 **Damage Or Deterioration:** Should provisions for the repair of damaged or deteriorated buildings (particularly those damaged by earthquakes) be included in the Guidelines?

ATC-28 Resolution: Do not include a specific method for assessing and rectifying deterioration or damage; however, specify that any damage or deterioration is to be taken into account in the seismic upgrading design in accordance with minimum quality standards to be included in the Guidelines.

Issue: Applicable

Resolution: Applicable and adequate

Note:ATC-28 suggests that this task not be within the scope of the FEMA document. Although it is reasonable to assume it would not be contained in the Guidelines for Federal Buildings, many jurisdictions have struggled with developing rules to determine which earthquake-damaged buildings must be strengthened and which ones need only repair. The lack of such policy causes much confusion after an earthquake, as there is great pressure to return buildings to use. Although not necessary for a seismic hazard mitigation program, the federal government would do well to develop a policy covering this situation.

2.4 **Non-Engineered Buildings:** Should the Guidelines include simplified provisions for buildings that are typically non-engineered, such as wood-frame dwellings or other small structures?

ATC-28 Resolution: The Guidelines writers should not attempt to provide simplified guidance to the non-engineering audience. That goal, specifically with regard to houses, deserves a separate project and document. No particular occupancy (such as single family dwelling) or class of construction (such as wood-frame) should be excluded from the scope of the Guidelines: that is an applicability issue beyond the Guidelines'

Issue: Applicable

Resolution: Applicable and adequate

Note: Non-engineered buildings, such as single family wood residences, etc., are not to be covered in the FEMA Guidelines. If the Guidelines for Federal Buildings are required to cover such buildings because of federal government ownership or because of loan regulations, guidelines will be needed. FEMA may also soon produce a separate document covering these buildings that could be used by federal agencies.

2.5 **Seismic Isolation and Energy Dissipation:** Should the Guidelines contain provisions covering the use of seismic isolation or energy dissipation systems in existing buildings?

ATC-28 Resolution: Seismic isolation and energy dissipation techniques should be included in the Guidelines, but only by stating that they are possible alternates to the conventional strengthening provisions of the Guidelines. Specific and detailed criteria available elsewhere should be discussed in the Guidelines to give guidance on how these separately published criteria might apply to existing rather than new buildings.

Issue: Applicable

Resolution: Applicable and adequate

3. *Implementation and Format Issues*

3.1 **Document Title:** What is the appropriate title for the Guidelines document?

ATC-28 Resolution: NEHRP Guidelines for Seismic Strengthening of Existing Buildings.

Issue: Not Applicable

Note: This issue is directed specifically at the FEMA project.

3.2 **Audience and Use:** To what audiences are the Guidelines directed, and how should the Guidelines be used?

ATC-28 Resolution: Write the Guidelines in a more tightly organized and less narrative form along the lines of a code or standard, emphasizing the role of the Guidelines as an interim step in the evolution of adopted codes and standards. The Guidelines should be aimed at the technical audience that is responsible for developing and using building codes and standards. Provide commentary in separate sections from the provisions themselves.

Issue: Applicable

Resolution: Applicable and adequate

3.3 **Involvement of Codes and Standards Development Groups:** How should model codes and standards organizations be involved in the development of the Guidelines to ensure their immediate consideration of relevant portions of the Guidelines?

ATC-28 Resolution: Obtain code development and implementation representation by including individuals with appropriate background as members of the Guidelines development team. Draw from a relatively broad list that includes national model code or standards organizations, architectural and engineering associations, trade or professional associations that have developed building standards in the past, and local, state or federal agencies that have developed or implemented building regulations.

Issue: Not Applicable

Note: This issue refers to the development process.

3.4 **Implementation Methods:** How will the Guidelines be implemented, and what kinds of information presented in the Guidelines would affect this implementation? [Editorial comment: This issue refers to implementation of the FEMA document, not seismic strengthening itself.]

ATC-28 Resolution: Assume the primary implementation of the Guidelines will be via adaptation and adoption into building codes and standards, and from there they will guide the work of engineers and building officials on a building-by-building basis. Anticipate a difficult adoption and implementation process because seismic strengthening can be costly and disruptive. Include a commentary and identify any valuable additional documents or projects that should be developed to assist in the implementation of the Guidelines. After the completion of the Guidelines, FEMA should sponsor the development of several explanatory companion documents, including the following: a design manual for engineers, architects, and building officials that contains illustrations and examples; a simplified explanation for non-engineers; the separate and simplified guidelines for dwellings recommended under Issue 2.4, Non-engineered Buildings.

Issue: Not Applicable

Note: Implementation of the document itself is not an issue for the Guidelines for Federal Buildings.

3.5 **Document Format:** Is a format with cross-referenced provision/commentary sections appropriate for the Guidelines, such as is used in the NEHRP provisions for new buildings or the SEAOC Recommended Lateral Force Requirements and Commentary?

ATC-28 Resolution: Provide a two-part inter-related document: one part written somewhat like a code and the second part containing matching sections with commentary, e.g., NEHRP provisions for new buildings (Building Seismic Safety Council, 1988; FEMA Publications 95 and 96) or SEAOC Blue Book (Structural Engineers Association of California, 1990).

Issue: Applicable

Resolution: Not Applicable

Note: The Guidelines for Federal Buildings will not be directly analogous to the FEMA Guidelines. The format will likely be different.

3.6 **Prescriptive Versus Analytical Provisions:** Should the provisions in the Guidelines be prescriptive or analytical?

ATC-28 Resolution: Use a combination of prescriptive and analytical provisions. Packages of prescriptive measures on the scale of entire strengthening systems would be defined for at least some of the simpler classes of construction, perhaps only in lower seismic zones. Where the Guidelines writers find that accuracy suffers unduly from the generalized prescriptive approach for a given category of construction, then they should provide analytical provisions instead.

Issue: Applicable

Resolution: Applicable and adequate

3.7 **Revising and Updating the Guidelines:** Once the Guidelines are produced, should they be revised and updated in the future?

ATC-28 Resolution: After their initial publication, the Guidelines should be updated and republished as a consensus document. This significant activity should be adequately supported to maintain a single nationally applicable set of provisions. This activity would not be in conflict with the separate process carried out by others of revision of versions of the Guidelines as adopted by model codes or standards organizations or particular jurisdictions.

Issue: Applicable

Resolution: Not Applicable

Note: A process must be instituted to update the Guidelines for Federal Buildings. This is particularly important up to the time the FEMA Guidelines can be used as a reference document.

4. *Issues of Coordination with Other Efforts*

4.1 **Relationship to Parallel Efforts:** How will the Guidelines relate to strengthening provisions already in use or currently being developed?

ATC-28 Resolution: Format the Guidelines so that both general design requirements developed apart from any existing document as well as techniques or systems for specific building types defined in existing related documents can be incorporated. Relevant portions of stand-alone provisions developed apart from the Guidelines can thus be more easily included.

Issue: Applicable

Resolution: Not Applicable

Note: Methods to incorporate acceptable methodologies in place in various agencies must be developed.

4.2 **Relationship to Building Evaluation Methods:** How are evaluation criteria contained in other documents to be reconciled with the strengthening criteria in the Guidelines?

ATC-28 Resolution: Do not include an evaluation method in the Guidelines but coordinate the Guidelines' provisions with current evaluation methods, such as ATC-22, ATC-22 in its eventual form as revised by BSSC, or ATC-26-1. Explain the relationship between evaluation and strengthening in the commentary to the Guidelines.

Issue: Applicable

Resolution: Applicable and adequate

4.3 **Relationship to Strengthening Techniques Studies:** How should the Guidelines be coordinated with other studies of seismic strengthening?

ATC-28 Resolution: Refer Guidelines readers to any relevant reports, particularly associated FEMA publications, but that material need not be included in the Guidelines. Use the categorization schemes in other FEMA reports unless other categorizations must be developed.

Issue: Applicable

Resolution: Applicable and adequate

4.4 **Relationships to Studies of Costs and Benefits:** How should past studies of seismic strengthening costs and benefits be related to the development of provisions in the Guidelines?

ATC-28 Resolution: The FEMA/VSP cost/benefit study and other relevant sources should be reviewed by the Guidelines writers for insights that may clarify the Guidelines' provisions.

Issue: Applicable

Resolution: Applicable and adequate

4.5 **Other Natural Hazards:** Should the seismic provisions in the Guidelines be coordinated or combined with provisions for other natural hazards such as wind?

ATC-28 Resolution: Provisions for wind or other non-seismic hazards should not be embedded within the Guidelines provisions. Provide conceptual information in the commentary on the relationships between wind and seismic requirements and guidance on how jurisdictions could most easily coordinate local wind requirements with the provisions of the Guidelines.

Issue: Applicable

Resolution: Applicable and adequate

Note: Although not necessary to a seismic hazard mitigation program, actual strengthening work should be coordinated with demands from other local natural hazards. Such a policy could be developed separately from the Guidelines for Federal Buildings.

5. *Legal and Political Issues*

5.1 **Standards of Care:** Should the Guidelines define appropriate professional standards of care?

ATC-28 Resolution: Accept the status quo. Absent a statutory grant of immunity from tort liability, there is relatively little benefit to be gained from trying to define standards of competence in the Guidelines. In fact, there are many more disadvantages than benefits because of the rigidities that would be established, given the evolving nature of earthquake engineering and design, and because of the inability to encompass all conditions and circumstances in anything but the most general of language.

Issue: Applicable

Resolution: Applicable and adequate

5.2 **Liability:** How should the possible liability of owners, designers, contractors, and regulatory agencies be considered in the development of the Guidelines?

ATC-28 Resolution: Assume that liability concerns cannot be eliminated, but that they are not a major barrier or concern in the writing of the Guidelines. The Guidelines should clearly state and define their purpose and intent (e.g., life safety) to the extent possible. They should include some narrative on their limitations (for instance, if the Guidelines are not designed to ensure the ability of a building after an earthquake). The Guidelines should also contain a disclaimer of any guarantee that adherence to the Guidelines will necessarily accomplish their purpose and intent.

Issue: Not Applicable

Note: This issue addresses the process of developing the FEMA Guidelines.

5.3 **Standards for New Versus Existing Buildings:** What are the legal implications of technical standards that differ for new and existing buildings, as exemplified by the current proposal in ATC-22 that 67% to 85% of the NEHRP base shear for new buildings be used as a basis for the evaluation of existing buildings?

ATC-28 Resolution: Develop different standards for existing buildings than new buildings according to good engineering judgment, even if those standards are lower than for new buildings, rather than limit the possible range of engineering solutions based on a fear of legal challenges. Attempt to provide information on the economic implications of lower versus higher standards, and on the relative degree of risk posed by existing buildings, but do not imply a warranty that use of the Guidelines will achieve a performance goal.

Issue: Applicable

Resolution: Applicable and adequate

5.4 **Impact Variation:** What are the legal and political implications of provisions that have different cost or benefit effects on different buildings?

ATC-28 Resolution: Assume that variation in impact and implied inequities are inevitable but are not barriers to the development of flexible Guidelines that discriminate among buildings based on engineering or social criteria.

Issue: Not Applicable

Note: This issue addresses the broad range of performance standards to be included in the FEMA Guidelines. Such a range will not be included in the Guidelines for Federal Buildings.

5.5 **Due Process and Taking Principles:** Do the Guidelines writers need to consider any strengthening cost limits that may be imposed by the constitutional process of due process and taking of property without just compensation?

ATC-28 Resolution: Cost should be a primary concern in the Guidelines writing process, but only for reasons other than concern over legal challenges: to keep the cost in reasonable proportion to the benefit, to increase the chances that the Guidelines will be adopted, and out of fairness and concern for owners, tenants, and others. So long as a strong public safety rationale and a strong nexus between the Guidelines and life safety exist, and so long as owners' property rights are not substantially diminished, the courts tend to uphold such regulatory measures, even in the face of great cost. Once the Guidelines writers have used their best judgement, they should let peer review, political processes, and finally court challenges, determine whether the costs are too high.

Issue: Not Applicable

Note: This issue does not apply to federal buildings.

6. *Social Issues*

6.1 **Affordable Housing:** How can the Guidelines be developed to reflect a concern for affordable housing?

ATC-28 Resolution: Institute a group or subcommittee to explore the problem and provide additional information to assist the Guidelines writers during the course of their tasks. This subcommittee should represent all the economic and social stakeholders and sources of information and cover all the social and economic issues discussed in this report. This subcommittee would review progress to ensure that these issues are appropriately considered. The scope of the committee's work would be limited to providing practical advice that is useful within the limits of the Guidelines' objectives.

Issue: Not Applicable

Note: This is not an issue with federal buildings.

6.2 **Social Impacts:** What are the possible social effects of the Guidelines (for example on ethnic or disadvantaged social groups) and, if detrimental, how can they be alleviated?

ATC-28 Resolution: Institute a group or subcommittee to explore the problem and provide additional information to assist the Guidelines writers during the course of their tasks. This subcommittee should represent all the economic and social stakeholders and sources of information and cover all the social and economic issues discussed in this report. This subcommittee would review progress to ensure that these issues are appropriately considered. The scope of the committee's work would be limited to providing practical advice that is useful within the limits of the Guidelines' objectives.

Issue: Not Applicable

Note: This is not an issue with federal buildings.

7. *Economic Issues*

7.1 **Direct Cost of Strengthening:** How should the evaluation of the direct cost implications of technical provisions be handled as the Guidelines are developed?

ATC-28 Resolution: Conduct short "ballpark" cost estimates, while the Guidelines are being developed, concerning specific criteria that appear to be significant.

Issue: Applicable

Resolution: Not Applicable

Note: A trial design program will be used to study costs for the Guidelines for Federal Buildings.

7.2 **Performance Benefit/Cost Relationships:** How can performance cost/benefit relationships be considered in the development of the Guidelines?

ATC-28 Resolution: Institute a group or subcommittee to explore the problem and provide additional information to assist the Guidelines writers during the course of their tasks. This subcommittee should represent all the economic and social stakeholders and sources of information and cover all the social and economic issues discussed in this report. This subcommittee would review progress to ensure that these issues are appropriately considered. The scope of the committee's work would be limited to providing practical advice that is useful within the limits of the Guidelines' objectives.

Issue: Not Applicable

Note: This issue addresses the process of developing the FEMA Guidelines.

7.3 **Social and Economic Implications of Alternative Standards:** What are the social and economic implications of alternative strengthening standards (for the same structural type in the same seismic zone) such as "life safety" versus "damage control" standards?

ATC-28 Resolution: Treat the issue only as a technical one. This is based on the assumption that mandatory standards will represent the minimum legal requirement, wherever the Guidelines' provisions are eventually adapted into regulations, and that any alternative standards would be voluntary. Voluntary alternative standards do not have social or economic implications that are relevant to the Guidelines writing process.

Issue: Not Applicable

Note: Alternative standards are not expected in the Guidelines for Federal Buildings.

7.4 **Local Government Economic Effects:** What are the economic implications of the Guidelines for local governments, and to what extent should local government representatives be involved in the development of the Guidelines?

ATC-28 Resolution: Institute a group or subcommittee to explore the problem and provide additional information to assist the Guidelines writers during the course of their tasks. This subcommittee should represent all the economic and social stakeholders and sources of information and cover all the social and economic issues discussed in this report. This subcommittee would review progress to ensure that these issues are appropriately considered. The scope of the committee's work would be limited to providing practical advice that is useful within the limits of the Guidelines' objectives. In addition to this alternative presented for the preceding social and economic issues, local government perspectives should be represented by ensuring that the subcommittee's composition includes local planning or building department backgrounds.

Issue: Not Applicable

Note: This issue addresses the process of developing the FEMA Guidelines.

7.5 **Associated Non-seismic Requirements:** How should seismic retrofit work be coordinated with or separated from enforcement of other life safety or retrofit requirements such as handicap access, asbestos removal, etc.?

ATC-28 Resolution: Ensure that any necessary technical coordination issues are covered in the Guidelines, but maintain a focus on seismic strengthening criteria. This alternative in effect suggests that this issue has no economic implications that directly affect the Guidelines writing process.

Issue: Not Applicable

Resolution: Not Applicable

Note: The interaction between seismic strengthening work and other life safety improvements, or other work mandated to the private sector, must be specifically addressed. If seismic strengthening is mandated on its own for any federal buildings, the issue must be raised concerning what other deficiencies should be corrected concurrently. If seismic strengthening is done only in conjunction with extensive remodels, this will be less of an issue. In any case, a policy on correction of non-seismic deficiencies will be necessary.

8. *Historic Building Issues*

8.1 **Inclusion or Exclusion of Historic Buildings**: Should the Guidelines include historic buildings within their scope?

ATC-28 Resolution: The Guidelines should not exclude buildings that have a historic designation from their scope. This approach will help preserve historic buildings from earthquakes, even if they are strengthened only up to a minimum life safety level, and prevent the situation from developing where the historic buildings will be the most hazardous in a community. Special design measures to strengthen a historic building without destroying historic features are an important topic, but outside the scope of the Guidelines. Historic building projects ultimately must be handled in the design process on a building-by-building basis by the owner, designer, building and/or planning departments, and community historic building organizations.

Issue: Applicable

Resolution: Applicable and adequate

8.2 **Standards for Historic Buildings**: If historic buildings are to be included within the scope of the Guidelines, should the provisions treat them the same as other buildings?

ATC-28 Resolution: Historic buildings should meet the same life safety criteria as other buildings. This will provide occupants and the public with a consistent level of safety. Provisions that provide various exceptions and alternatives for historic buildings could always be locally adapted, particularly if the Guidelines are developed with a format of multiple performance standards as discussed in Issue 11.2, Performance Goals. Writing detailed provisions on how to seismically

preserve historic buildings is beyond the scope of the Guidelines. Even a small topic, such as restoration and strengthening of terra cotta exterior ornamentation, would require a manual of its own. This issue is better dealt with as a design problem on a local and case-by-case basis.

Issue: Applicable

Resolution: Not applicable

Note: The FEMA Guidelines will have no special provisions for historic buildings. It is argued that the seismic strengthening requirements are the same for all buildings, dependent only on appropriate performance goals. The development of special considerations, strengthening techniques, and details that preserve historic character are therefore considered beyond the scope of the FEMA document and is assumed to be controlled by local jurisdictions. If the Guidelines for Federal Buildings result in an extensive amount of seismic strengthening, historic buildings are sure to be affected and a supplementary document covering policies on preservation and controls on strengthening techniques will be necessary.

9. *Research and New Technology Issues*

9.1 **Innovative Risk Reduction Methods**: How can innovative risk reduction systems, materials, or construction technologies and products be quickly verified, approved, and brought into use?

ATC-28 Resolution: Since administrative procedures will vary from jurisdiction to jurisdiction, it is not appropriate for the Guidelines to suggest a local approval method. However, criteria that would allow local judgements of equivalency should be included. Keeping the Guidelines up-to-date and evaluating major innovations in the field is separately recommended under the Revising and Updating the Guidelines issue (Issue 3.7).

Issue: Applicable

Resolution: Not applicable

Note: ATC-28 suggests that innovative techniques should be encouraged but will be approved at the local level. Often lacking local building department expertise, federal agencies may need guidelines for approval of such systems, peer review requirements, etc.

9.2 **Dependence on Recent and Future Research:** What areas of the Guidelines are dependent on recent or future research, and is it feasible to write effective Guidelines at the present time?

ATC-28 Resolution: Although there are deficiencies in our store of research knowledge, effective provisions can now be written. Given the accelerating interest in research in existing buildings and the probable length of time for completion of the Guidelines, a group or subcommittee of the Guidelines writers should monitor and review recent and ongoing research and to make recommendations to the Guidelines authors.

Issue: Applicable

Resolution: Applicable and adequate

10. *Seismicity and Mapping Issues*

10.1 **Defining Ground Shaking Hazard:** Should the Guidelines use the same maps and methods for defining ground shaking hazard as have been developed for new buildings, or should a different approach be devised?

ATC-28 Resolution: Use the same maps and methods as specified in current NEHRP provisions for new buildings. Maps based on both 10% exceedance in 50 years (as are typically used in the design of new buildings) and 10% exceedance in 250 years, as presently in the 1988 edition's appendix to chapter 1 of the Commentary, should be considered in the development of the Guidelines.

Issue: Applicable

Resolution: Applicable and adequate

10.2 **Soil Instability and Other Geologic Hazards:** How should structural strengthening criteria be influenced by knowledge of unfavorable soil conditions that could cause failure of an otherwise adequate structure?

ATC-28 Resolution: Provide commentary relating the severity of geologic hazard being considered to the approximate cost levels and benefits of realistic mitigation measures applicable to a building's site. Combinations of building and foundation type and soil instability that may create life safety hazards should be differentiated from situations which are more likely to only cause damage to the site or building. The preparation of such a discussion, intended for the commentary, may result in some clearly defined mitigation measures that should be placed in the provisions.

Issue: Applicable

Resolution: Applicable but requires technical development

Note: It is proposed that combinations of conditions that would warrant mitigating action would be identified in the FEMA Guidelines. No such guideline currently exists.

10.3 **Soil Amplification:** Should soil amplification of ground motion be considered in a manner similar to new building design procedures?

ATC-28 Resolution: The amplification of ground motion induced by soft soils should be considered when designing retrofit measures for an existing building by modifying force levels as in the NEHRP provisions for new buildings.

Issue: Applicable

Resolution: Applicable and adequate

11. *Issues of Engineering Philosophy and Goals*

11.1 **Definition of "Life Safety":** How should the goal of life safety be specifically defined?

ATC-28 Resolution: Life safety should be defined simply as the intent to prevent collapse and falling hazards in the "design event", which must be explicitly defined to give "life safety" meaning. Because of the differences in characteristics of larger events of the country (see Strengthening Provisions in Different Zones, Issue 11.5), both the 10% probability of exceedance in 50 years event and the 10% probability in

250 years criterion as shown in NEHRP mapping (chapter 1 appendix, 1988 edition) should be considered when such a determination is made.

Issue: Applicable

Resolution: Applicable and adequate

11.2 **Performance Goals:** What seismic performance goals should be covered by the Guidelines?

ATC-28 Resolution: The Guidelines should incrementalize and prioritize strengthening activities to the greatest extent practicable. The performance expectation of each increment that is identified would be given. Although the number of appropriate increments of performance goals may vary by building type and zone, a set of requirements for life safety would always be specified and would form the core of the Guidelines. These tables would be presented together in an Application of Provisions section analogous to expanded NEHRP Seismic Performance Categories.

Issue: Applicable

Resolution: Not applicable

Note: The FEMA Guidelines will present a wider variety of performance goals than will be necessary for federal buildings. A policy document that delineates what performance goals are required under various conditions will be required for the Guidelines for Federal Buildings. Standards that are intended to meet such a variety of performance goals for all building types are not currently available.

11.3 **Incremental Strengthening:** Should the Guidelines allow incremental strengthening and provide a systematic method for the definition of appropriate strengthening levels?

ATC-28 Resolution: Incremental strengthening should be controlled by the local jurisdiction. Mandated programs would specify what, if any, incremental strengthening is allowed. When strengthening is not mandated, the Performance Goal (Issue 11.2) and Voluntary

Strengthening (Issue 11.4) issues would apply. Incremental strengthening should be covered in the Guidelines to the extent possible, but the application should be left to the implementing jurisdiction.

Issue: Applicable

Resolution: Not applicable

Note: Although not required as part of a useful federal guideline, this issue will definitely come up on an agency level. It could be left to be resolved at the agency level, or a policy could be developed for the guidelines. This could logically become part of the implementation document mentioned in Issue 2.2.

11.4 **Voluntary Strengthening**: If strengthening is not legally required, is voluntary strengthening to a lower standard acceptable, and how would this lower standard be defined in the Guidelines?

ATC-28 Resolution: Voluntary strengthening should not be prohibited in the Guidelines. Guidance for both selection of voluntary strengthening and control by local jurisdictions could be obtained from the proposed format of the multiple performance standards (Performance Goals, Issue 11.2).

Issue: Applicable

Resolution: Not applicable

Note: Similar to Issue 11.3, a policy on this kind of seismic strengthening work could be resolved locally or could become a part of the implementation document.

11.5 **Strengthening Provisions for Different Seismic Zones:** How should the procedures and provisions of the Guidelines vary among different seismic zones?

ATC-28 Resolution: Utilize zones determined from alternative #1 and incorporate probable performance for loadings described in both alternative #1 and #2 where a large difference is apparent. These expected performance levels should become part of the multiple performance standard matrices described in Issue 11.2, Performance Goals.

Issue: Applicable

Resolution: Applicable and adequate

11.6 **Remaining Life of Building:** Should the strengthening level be related to the remaining life of the building?

ATC-28 Resolution: Remaining life should not be a formatted parameter in force level or other requirements. Commentary should be included, however, that discusses options in cases where there is a short anticipated life. The recommended procedure would probably be different for mandated strengthening than for voluntary strengthening.

Issue: Applicable

Resolution: Applicable and adequate

11.7 **Occupancy:** Should occupancy, both type and load, be considered in the Guidelines?

ATC-28 Resolution: Combine the implied change in performance for different Seismic Hazard Groups with the multiple performance standards proposed for the Guidelines for other reasons (see Performance Goals, Issue 11.2). Performance standards that are desirable for different Seismic Hazard Groups would be specified.

Issue: Applicable

Resolution: Applicable and adequate

11.8 **Contribution of Nonstructural Elements:** Should elements that are traditionally considered non-force-resisting be utilized for lateral load resistance, and, if so, what provisions are appropriate?

ATC-28 Resolution: The wide variety of elements and systems that could be used make their direct inclusion in the Guidelines almost impossible. The Guidelines should therefore include general criteria by which such an element or system could be qualified for use.

Issue: Applicable

Resolution: Applicable but requires technical development

Note: This is one of the biggest issues in current attempts to define economical strengthening methods. The only building type where a standard has been developed is unreinforced masonry bearing wall buildings.

12. *Issues in the Development of Specific Provisions*

12.1 **Minimum Quality Standards and Testing:** How should the Guidelines define standards for minimum acceptable information on as-built conditions, including both configuration and quality of the existing structure?

ATC-28 Resolution: Create criteria for successful performance (maybe a set of minimum material properties) and critical information on as-built conditions to be applied to all significant elements of the structure. Criteria for lateral force resisting elements may be difference than for vertical load supporting elements. Testing methods or standards should also be included.

Issue: Applicable

Resolution: Applicable but requires technical development.

Note: The stated minimum standards specifically related to seismic strengthening do not currently exist and are intended to be developed in the FEMA document.

12.2 **Strength Versus Working Stress Design:** Should the Guidelines be written on a strength or working stress design basis?

ATC-28 Resolution: Follow the NEHRP limit state format, altered as required for existing buildings.

Issue: Applicable

Resolution: Applicable and adequate

12.3 **Force Level Definition Procedure:** What general procedure should be used in the Guidelines for the definition of design force levels?

ATC-28 Resolution: Use of a factor, in many cases less than 1.0, and that may vary by zone and performance goal, times the force level defined in the latest version of NEHRP provisions for new buildings.

Issue: Applicable

Resolution: Applicable and adequate

12.4 **Drift Limits:** Should interstory drift and other distortion limits of the type that are imposed in the design of new buildings be applied to existing buildings?

ATC-28 Resolution: Use estimated drift as one of the key parameters to determine acceptability of existing elements and requirements for added systems, within the overall performance goal under consideration.

Issue: Applicable

Resolution: Applicable but requires technical development.

12.5 **Consideration of Detailing of Existing Systems:** How should as-built detailing that is not in conformance with current detailing practice be treated in the Guidelines?

ATC-28 Resolution: a) [for elements that are part of the primary lateral force resisting system] Develop a separate Response Modification Coefficient Table for representative existing systems or elements and use procedures analogous to NEHRP provisions for new buildings; b) [for other elements] Develop an additional system of control over designs based on drift limits of various existing systems, including the detailing. These controls would be equivalent to the deformation compatibility requirements for new buildings.

Issue: Applicable

Resolution: Applicable but requires technical development.

12.6 **Detailing for New Elements:** Should the introduction of new structural elements be controlled by the provisions for new construction or included within the Guidelines as a special existing building topic?

ATC-28 Resolution: The Guidelines should only include provisions for new elements that are not adequately covered by the NEHRP provisions for new buildings.

Issue: Applicable

Resolution: Applicable and adequate

12.7 **Compatibility of Old and New Construction:** How should the compatibility of existing and added lateral systems be accomplished: prescriptively, or by performance projected by analysis?

ATC-28 Resolution: Performance criteria for deformation or other compatibility should be given, allowing the designer to use any combination of systems as long as stiffness compatibility is maintained.

Issue: Applicable

Resolution: Applicable and adequate

12.8 **Foundations:** Should foundation strengthening be included within the Guidelines, and if so, what provisions should apply?

ATC-28 Resolution: Develop a methodology that considers yielding modes of various foundation/soil type combinations and establishes acceptable factors of safety for such yielding at projected real earthquake loads. "Real" earthquake loads could be established by using multiples of forces established by Response Modification Coefficients. Both bearing pressures (overturning) and sliding mechanisms must be considered. The result of carrying out this alternative may be the production of simplified allowable pressure increases as suggested in Alternative #2.

Issue: Applicable

Resolution: Applicable but requires technical development.

12.9 **Unreinforced Masonry Partitions:** How should the Guidelines treat unreinforced masonry partitions, such as those made of hollow clay tiles or concrete masonry units?

ATC-28 Resolution: Require retrofit if the Guidelines' provisions for the following conditions are not met: H/t ratio, quality, edge restraints, and deformation limits that are acceptable in various building locations (exterior wall, stairwell, room separators, etc.).

Issue: Applicable

Resolution: Applicable but requires technical development.

12.10 **Adjacency Conditions:** How can adjacency conditions such as pounding or common walls be taken into account?

ATC-28 Resolution: Require consideration of the results of impact and interaction by both building owners of adjacent properties if clearances are less than specified values. Provisions for seismic joints within buildings may be different than at property lines. Strengthening of any building involving property line contact or near contact with an adjacent building, such as by adding supplementary vertical support, could therefore require action of a neighbor. This is similar to the coordination required by excavations at property lines. Require consideration of the adequacy of common walls considering all vertical and lateral loads supported by the wall. Strengthening a building could therefore require action of a neighbor similar to excavation at property lines.

Issue: Applicable

Resolution: Not applicable

Note: The ATC-28 resolution of this issue would suggest that the strengthening of a given building may require mitigation work on adjacent buildings. It will be difficult to accomplish this mandate for federal buildings. It is more likely that notification of adjacent owners may be appropriate. However, the interaction of adjacent buildings or other improvements such as lifelines (with different owners) is considered a serious problem, and a policy to define appropriate action for the federal government will be needed.

12.11 **Exterior Falling Hazards**: How should the Guidelines treat a building's exterior hazards, such as potential falling appendages or other debris?

ATC-28 Resolution: Include provisions in the Guidelines covering all types of exterior falling hazards. Prioritize these items considering the relative hazard presented. Separate these items as independent or dependent on structural response so that hazard reduction programs for some components can be developed independently of structural strengthening.

Issue: Applicable

Resolution: Applicable and adequate

12.12 **Alternate Analysis Methods**: How can analysis methods be accommodated that are not specifically covered in the Guidelines?

ATC-28 Resolution: Require structures strengthened using alternate or advanced analysis to conform within certain ranges of normally applicable conventional provisions until consensus can be reached on codification.

Issue: Applicable

Resolution: Not applicable

Note: This is proposed to be resolved at the local level. A federal policy will be required.

12.13 **Quality Control**: Should field quality control for retrofit work differ from that of new construction?

ATC-28 Resolution: Recommended field quality control for elements or techniques unique to seismic strengthening should be included in the Guidelines. The design engineer should be involved in construction observation. The Guidelines should contain provisions for a project-specific construction quality control program to be included in the design documents and some degree of monitoring of that program by the design engineer.

Issue: Applicable

Resolution: Applicable and adequate

13. *Nonstructural Element Issues*

13.1 **Inclusion or Exclusion of Nonstructural Elements:** Should the Guidelines include nonstructural elements within their scope?

ATC-28 Resolution: Include nonstructural elements in the Guidelines.

Issue: Applicable

Resolution: Applicable and adequate

13.2 **Standards for Nonstructural Elements:** If nonstructural elements are included in the Guidelines, should they be treated as for new buildings?

ATC-28 Resolution: For buildings whose performance goal is life safety, define the scope of the Guidelines' treatment of the nonstructural topic to be narrower than current provisions for new buildings: Begin with the list of nonstructural elements provided by current building codes, guidelines, and standards, but reduce the list to the essential minimum based on considerations of which items are most likely to be serious life safety problems. The result would be that some items that would have to be braced or anchored in new buildings would not have to be retrofitted according to the provisions of the Guidelines. For buildings whose performance goal includes protection of essential function, the Guidelines may be the same as nonstructural provisions for new buildings. The scope would not include contents and equipment that are outside the scope of typical building code provisions.

Issue: Applicable

Resolution: Applicable and adequate

Leased Buildings: How can the federal government accomplish the strengthening of leased buildings, particularly those where federal occupancy is only partial?

If federal occupancy of a building is 100%, negotiations with the landlord to seismically strengthen the building may be successful. Cases of federal occupancy will prove more difficult, as strengthening of a part of a building is seldom feasible. If strengthening cannot be accomplished and the occupancy/facility has been rated as having a high seismic priority, alternate space can be obtained. A policy for leased buildings should be developed, including appropriate differences between short and long term leases.

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TABLES

AGENCY	# OF BLDGS	INVENTORY?	DETAILED STR'NG. PROGRAM?	COMMENTS
Agriculture	None	Yes-RE	No	Govt. loans for single family homes. Do some clinic & hospital work in rural areas. (1/2 new, 1/2 as-built)
Architect of the Capitol	17	No	No	All buildings in Washington D.C. No seismic program.
Commerce	2600	GSA	No	Lease all space from GSA. Only significant program builds radar dishes.
Defense/Army	???	Yes	Yes	Many buildings screened and evaluated using RSAP. Some detailed evaluations performed. Have manual by CERL for evaluations.
Defense/Navy	???	Yes	Yes	RSAP, detailed evaluations, and strengthenings on a number of buildings. Documentation available.
Defense/Air Force	13000	Yes	Yes	Use Tri-services program but cannot design & construct - rely on Army & Navy for buildings.
Education	150	GSA	No	Schools located on military bases all around U.S. and world. Uses Health & Human Services EQ program.
Energy	11000	Yes-RE	Yes	Full program of UCRL documents. Safety analysis program + nonstructural program based on LLNL.
Environmental Protection Agency	???	GSA	No	No program for new, existing or prepurchase and no plans for any programs.
FEMA	None	GSA	No	Fund NEHRP provisions. Fund construction for a few projects and for disaster relief (>51% damage)
General Services Administration	10000	Yes-RE	Yes	Full featured program with triggers, evaluation & strengthening. Not much implementation due to budget.
Health & Human Services	2600	Yes-RE	No	Hospitals and labs all over the U.S. on Indian reservations not covered by GSA.
Housing & Urban Development	Many	No	No	USGS is currently setting up a seismic risk assessment program but key problem is no building inventory.
Interior/ Reclamation	75	GSA	No	Most seismic safety w/ dams & pumping plants. Office buildings are mostly small and covered by GSA.

RE=Real Estate

Table 1: Summary of Telephone Conversation Results (1 of 2)

AGENCY	# OF BLDGS	INVENTORY?	DETAILED STR'NG. PROGRAM?	COMMENTS
Interior/USGS	6	Yes	No	Have program at Menlo Park written in-house. Not applicable outside USGS.
Justice	58	GSA	No	Lease all but a few buildings from GSA.
Justice/Federal Bureau of Prisons	1400	No	No	Have all types and sizes of federal prison buildings but are waiting for Justice Dept. to mandate.
Labor	None	No	No	Interested in safety of workers.
NASA	???	Yes-RE	No	Rely on structural consultants for JPL work. Agababian did equipment bracing and strengthening for JPL.
NSF	None	No	No	Blanketed by GSA seismic program. Probably do not need to meet ICSSC guidelines.
Nuclear Regulatory Commission	12	GSA	No	All office space from GSA in Wash. D.C. Seismic guidelines for nuclear facilities not applicable.
Postal Service	35,500	Yes	Yes	ATC-26-1: evaluation of existing buildings. ATC-26-4: retrofit program. 110 building pilot program in Western U.S., primarily in CA.
Small Business Admn.	None	GSA	No	Lease all building space from GSA.
Smithsonian	50	GSA	No	Developing policy statement and currently setting up RP-3 program.
State	8000	Yes-RE	Yes	Rely on consultants for eval. & strengthening. Renovation "trigger" is most potent. New constr. guidelines.
Tennessee Valley Authority	450	Yes-RE	Started	New constr. & disaster mitigation RP-3 program established. NRC Guidelines used for nuclear facilities.
Transportation	100	Yes	No	Intend to follow RP-3 on its timeline.
Transportation/ Coast Guard	10000	Yes	Yes	Used NTSC program for rapid screening of 1000 buildings. Soon to do prelim. eval. of top 100. Alameda currently strengthening two buildings.
Treasury	???	GSA	No	95% space leased by GSA. Very little owned construction if any.
Veterans Affairs	4891	Yes	Yes	1971 program w/ Phase I & Phase II evaluations, numerous strengthening projects. H-08-8 guidelines currently being revised.

RE=Real Estate

Table 1: Summary of Telephone Conversation Results (2 of 2)

AGENCY	DOCUMENT	WHEN TO STRENGTHEN	PERFORMANCE	LEASED?	RAPID SCREEN
Navy	NAVFAC P-355	Renovation of \$150k or 10% replace cost	85% life-safe 15% fully functional	None	Computerized - eliminates UBC zones 0,1,2
DOE	UCRL-15910	None	Life-safety for low hazard facilities	Leases all space from GSA	None
GSA	Chapt. 12 GSA Hndbook	Renovation of \$1500k or 50% replace cost	Life-safety	Must comply w/ 1976 UBC	DFA based on max 275 points
USPS	ATC-26-1 ATC-26-4	None	Life-safety	Same requir. as for owned	Computerized - assign Groups
FBO	UBC	Renovation	Life-safety as minimum	Same requir. as for owned	None
Coast Guard	Chapt. 10 USCG Hndbook	Renovation	Life-safety fully-funct.	None	Computerized - NTSC screening
VA	H-08-8 UBC	Renovation	90% life-safe 10% fully functional	80% current UBC code	Eliminate UBC zones 0 & 1
HP	ATC-14 UBC	None	Life-safety repair. dmg. fully funct.	None	Computerized - seismicity
Kaiser	ATC-14 UBC Title 24	Pre-1973 hospitals	Life-safety repair. dmg. fully-funct.	None	Eliminates all leased buildings
Stanford	UBC UCBC	Perf. object. + SB-547	Life-safety Repair. dmg. fully-funct.	None	Predicted bldg. performance ranking
Rocket-dyne	NAVFAC P-355 w/ modific.	Performance objectives	Life-safety repair. dmg. fully-funct.	None	Predicted bldg. performance ranking

Table 2: Summary of Detailed Interview Results (1 of 2)

AGENCY	PRELIM. EVAL.	DETAILED EVAL.	STRENGTH. GUIDES	NONSTRUCTURAL
Navy	RSAP by A/E >60% damage requires D.E.	Guidelines for A/E given in MIL-HDBK 1190 and P-355.2	LS: P-355.2 FF: P-355.1	Guidelines given in P-355.2
DOE	A/E	A/E	100% of current UBC code	None
GSA	None	A/E w/ scope of work	80% of current UBC code	Current UBC code
USPS	ATC-26-1 checklists	ATC-26-1 guidelines	80% of NEHRP ATC-26-4 guidelines	80% of NEHRP ATC-26-4 guidelines
FBO	A/E w/ Phase I scope of work	A/E w/ Phase II scope of work	100% of current UBC code for projects to date. Other levels could be used depending on the situation.	Procedures being developed
Coast Guard	A/E	A/E	???	None
VA	A/E w/ Phase I scope of work	A/E w/ Phase II scope of work	LS: 100% of UBC FF: 85% of H-08-8	None
HP	ATC-14 checklist	A/E w/ scope of work	LS: 100% of ATC-14 RD: 100% of UBC FF: 150% of UBC	Custom handbook of details
Kaiser	ATC-14 checklists	A/E w/ scope of work	LS: 100% of ATC-14 RD: 100% of UBC FF: 100% of Title 24	Custom details
Stanford	None	A/E w/ scope of work	LS: .13 UBC, UCBC RD: 100% of UBC FF: 150% of UBC	A/E w/ building strengthening
Rocketdyne	None	A/E using site specific eq. and company guidelines	Site specific eq: 75yr, 475yr, 2475yr w/ minimum = UBC	Custom procedures and details

Table 2: Summary of Detailed Meeting Results (2 of 2)

Earthquake Performance Objectives for Existing State Buildings

Earthquake Performance Objectives	Post-Earthquake Functions Within	Building Standards[1]	Occupancy Categories[2]							
			Hospitals, Essential Services	Hazardous Materials	Public Schools	Nursing, Prisons	University, Research	Offices, Courts	Other Occupancies	Historic, Non-essential
Fully Functional, no significant damage	Immediate	Nuclear Reg. Commission	✳	✳	✳	✳	✳	✳	✳	✳
Immediate Occupancy, minimal post-earthquake disruption, some non-structural cleanup required	Hours	Title 24 I = 1.50, 1.25	✦[3]	O[4]	O	O	O	O	O	O[5]
Repairable Damage, some structural and nonstructural damage, will not significantly jeopardize life	Days to Months	Title 24 I = 1, 1.15 Current UBC[6]	●	O[4]	O	O	O	O	O	O[5]
Substantial Life Safety, significant damage may not be repairable, will not significantly jeopardize life	Year(s)	75% of the 1988 UBC; ATC 14 & 22; or 1978 UBC[7]	●	✦[4]	✦	✦	✦	✦	✦	O[5]
Life Hazards Reduced, unrepairable damage very likely, some falling hazards, building may be a total loss, low life hazards.	No Limit	UCBC Appendix Ch. 1 for URM Bearing Wall Buildings	●	●	●	●	✦[8]	✦[8]	✦[8]	✦[5]
Very Poor Life Safety, collapse likely, unrepairable damage and total loss highly likely, significant life hazards	No Limit	None	●	●	●	●	●	●	●	●
Unsafe for Occupancy	No Limit	None	●	●	●	●	●	●	●	●
Unknown Performance	No Limit	None	●	●	●	●	●	●	●	●

Key:
- ✦ = Minimum Acceptable Earthquake Performance Objective
- O = Acceptable Earthquake Performance Objective
- ● = Unacceptable Earthquake Performance Objective
- ✳ = Typically does not apply, except to nuclear facilities

Abbreviations:

ATC—Applied Technology Council
I—Occupancy Importance Factor (pursuant to Ch. 23, Title 24)
Title 24 (Part 2, California Code of Regulations)—California Building Code
UBC—Uniform Building Code
UCBC—Uniform Code for Building Conservation
URM—Unreinforced Masonry

Footnotes:

1—Most building standards are not currently required by law for existing buildings, unless triggered by voluntary or mandatory strengthening, major alterations, additions, or changes of occupancy. This policy recommends that all existing state government buildings meet minimum earthquake performance objectives by the year 2000.
2—Emergency and recovery plans required for all occupancies.
3—Communications, emergency services, and acute care services shall be capable of functioning after earthquakes, as well as having immediate occupancy throughout the building.
4—Acceptable if chance of release of hazardous materials is remote.
5—Acceptable if anticipated earthquake damage is repairable, and the building also complies with the State Historical Building Code.
6—Applies to state leased buildings.
7—A uniform seismic retrofit building standard must be developed.
8—Acceptable for strengthened URM bearing wall buildings only.

Table 3: State of California Performance Matrix

Key:
◆ = Minimum Acceptable Earthquake Performance Objective
○ = Acceptable Earthquake Performance Objective
● = Unacceptable Earthquake Performance Objective
* = Typically does not apply, except to nuclear facilities

Earthquake Performance Objectives	Post-Earthquake Functions Within	U.S. POST OFFICE		GSA		NAVY		VA			FBO	DOE				COAST GUARD	
		FACILITIES CRITICAL TO OPERATION	NORMAL FACILITIES	OWNED FACILITIES	LEASED FACILITIES	ESSENTIAL FACILITIES	NORMAL FACILITIES	HOSPITALS	MOD*	LEASED FACILITIES	ALL BUILDINGS	HIGH HAZARD	MODERATE HAZARD	LOW HAZARD	GENERAL USE	CATEGORY 1	CATEGORY 2, 3, & 4
Fully Functional, no significant damage	Immediate	*	*	*	*	*	*	*	*	*	*	◆ UCRL	◆ 15910	*	*	*	*
Immediate Occupancy, minimal post-earthquake disruption, some non-structural cleanup required	Hours	○	○	○	○	◆ P-355.1	○	◆ H-08-8	○	○	○	●	●	◆ UBC I=1.25	○	◆	○
Repairable Damage, some structural and nonstructural damage, will not significantly jeopardize life	Days to Months	◆ ATC26-1 APP. E	○	○	○	●	○	●	◆ UBC	○	◆ 100% of UBC	●	●	●	◆ UBC	●	○
Substantial Life Safety, significant damage may not be repairable, will not significantly jeopardize life	Year(s)	●	◆ 80% of NEHRP	◆ 80% of UBC OR	◆ 1976 UBC	●	◆ P-355.2	●	●	◆ 80% of UBC	●	●	●	●	●	●	◆
Life Hazards Reduced, unrepairable damage very likely, some falling hazards, building may be a total loss, low life hazards.	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Very Poor Life Safety, collapse likely, unrepairable damage and total loss highly likely, significant life hazards	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Unsafe for Occupancy	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Unknown Performance	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Table 4: Govenment Agencies Performance Matrix

Key:
◆ = Minimum Acceptable Earthquake Performance Objective
○ = Acceptable Earthquake Performance Objective
● = Unacceptable Earthquake Performance Objective
* = Typically does not apply, except to nuclear facilities
(1) = Tri-services procedure with UBC as minimum.

Earthquake Performance Objectives	Post-Earthquake Functions Within	HEWLETT-PACKARD				KAISER			STANFORD			ROCKETDYNE			
		CATEGORY A	CATEGORY B	CATEGORY C	ALL BLDGS. w/ HIGH LIFE SAFETY	HOSPITALS	MOBS	SUPPORT FACILITIES	CLASS A	CLASS B	CLASS C	CATEGORY A	CATEGORY B	CATEGORY C	CATEGORY D
Fully Functional, no significant damage	Immediate	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Immediate Occupancy, minimal post-earthquake disruption, some non-structural cleanup required	Hours	◆ UBC w/ restrictions I=1.5	○	○	○	◆ Title 24	○	○	◆ UBC I=1.5	○	○	◆ (1)	○	○	○
Repairable Damage, some structural and nonstructural damage, will not significantly jeopardize life	Days to Months	●	◆ UBC w/ restrictions	◆ UBC	○	●	○ UBC	○	●	◆ UBC	○	●	◆ (1)	○	○
Substantial Life Safety, significant damage may not be repairable, will not significantly jeopardize life	Year(s)	●	●	●	◆ ATC-14	●	◆ ATC-14	◆ ATC-14	●	●	UBC 0.13g MAX ◆ UCBC 0.13g	●	●	◆ (1)	○
Life Hazards Reduced, unrepairable damage very likely, some falling hazards, building may be a total loss, low life hazards.	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	◆ (1)
Very Poor Life Safety, collapse likely, unrepairable damage and total loss highly likely, significant life hazards	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Unsafe for Occupancy	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Unknown Performance	No Limit	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Table 5: Private Sector Organizations Performance Matrix

APPENDICES

APPENDIX A

Scope of Work

Detailed Work Plan

SECTION C - DESCRIPTION/SPECIFICATIONS/WORK STATEMENT

C.1 STATEMENT OF WORK/SPECIFICATIONS

The Contractor shall furnish the necessary personnel, material, equipment, services and facilities (except as otherwise specified), to perform the following Statement of Work/Specifications.

Background: Section 8(a) of the NEHRP Reauthorization Act (Public Law 101-614) calls upon the Interagency Committee on Seismic Safety in Construction (ICSSC), chaired by NIST, to work in consultation with appropriate private sector organizations to develop standards for assessing and enhancing the seismic safety of existing buildings constructed for or leased by the Federal Government.

In support of ICSSC objectives to develop seismic standards for existing federal buildings, the contractor shall perform the following tasks. The contractor shall be responsible for acquiring the reports, codes, standards, and other documents and information required to be reviewed by this contract or otherwise necessary for completion of the tasks below. During the period of the contract, the contractor shall submit monthly written reports. These reports shall include, for both contractor and any and all subcontractors, at a minimum, a brief description of work accomplished during the previous month, an estimation of the percent of each task completed, a description of any problems hindering timely progress of the work, and an identification of any anticipated problems which are expected to hinder work in the future. As requested by the COTR, the contractor shall provide NIST with copies of work in progress, in the form of drafts of the reports and plans described in the tasks below.

<u>Task 1</u>

a. The contractor shall prepare a draft report containing, but not limited to, the following information:

- A detailed workplan for the project.
- An identification of existing and proposed federal agency evaluation and strengthening programs, including rapid screening processes. The listing shall be, to the greatest extent possible, comprehensive, and shall include the program of the United States Postal Service.
- A compilation of existing and proposed federal, state, and private sector seismic performance objectives for existing buildings, including performance objectives of at least six federal agency programs identified above. Among the additional relevant documents to be included is the California Seismic Safety Commission document "Policy on Acceptable Levels of Earthquake Risk in State Buildings".
- A matrix of recommended performance objectives by occupancy and seismicity for existing federally owned or leased buildings, and rationale behind the recommendations.

- A review of ATC 28 issues for applicability to requirements for federal buildings, and rationale defending identification of any issues deemed not relevant to the federal effort.
- An identification of any issues not included in ATC 28 that are relevant to the federal effort.
- Recommended resolution of applicable issues identified above, and rationale behind the recommendations.

b. Based on NIST and ICSSC review comments on the draft report, the contractor shall prepare a final report.

Task 2

a. The contractor shall prepare a draft report containing, but not limited to, the following information:

- An assessment of at least six existing federal evaluation and strengthening programs identified in task 1, including but not limited to a comparison of relevant portions of federal programs to the most recent versions of "The NEHRP Handbook for Seismic Evaluation of Existing Buildings" and "The NEHRP Handbook for Techniques for Seismically Rehabilitating Existing Buildings".
- An identification and assessment of the rehabilitation criteria currently in use, recommended for use, or in development by federal, state, local, or private organizations. The six federal programs reviewed above, ICSSC Recommended Practice 3, "Guidelines for Identification and Mitigation of Seismically Hazardous Existing Federal Buildings", and at least four other programs known to the contractor shall be included in the study. Criteria to be assessed shall include, but are not limited to:
  - "triggers" that require rapid hazard screening, detailed capacity assessment, or other evaluation to be performed,
  - level of understrength or other criteria that require strengthening, stiffenening, or other risk-reduction efforts to be initiated,
  - levels of strength or stiffness to be achieved,
  - time frames specified for evaluation or strengthening,
  - exemptions from evaluation and strengthening programs and rationale for such exemptions.
- A detailed summary of seismic evaluation and strengthening standards for existing buildings, including rehabilitation criteria being developed for general use by FEMA (or contractor to FEMA).

b. Based on NIST and ICSSC review comments on the draft report, the contractor shall prepare a final report.

Task 3

a. The contractor shall prepare a draft plan for a trial design program to develop a rational basis for recommending minimum required strength levels for retrofit of existing structures. The trial design program shall consider, as a minimum, seismicity, performance objective, structural system, retrofit method, and level of strengthening. The contractor shall recommend the number and

structural type of buildings to be assessed. Rehabilitation costs shall be determined as part of the trial designs.

b. Based on NIST and ICSSC review comments on the draft plan, the contractor shall prepare a final plan.

<u>Task 4</u>

The contractor shall establish a panel of five experts from the private sector to review draft reports and plans. Selection of panel members shall be made jointly with NIST. The contractor shall arrange for at least two meetings of this panel, at a location within the continental United States that minimizes travel for the contractor and the panel members. Dates of the two meetings of the expert panel shall be established by the contractor in consultation with NIST. The contractor shall be responsible for meeting room costs; travel, board and lodging costs for panel members; and any other costs incurred in completion of this task. The panel will review the draft versions of reports and plans described above. The contractor shall produce mintues of the meetings and incorporate comments of the review panel in the final drafts of the documents.

a. The first of the two required meetings shall be held.

b. The second of the two required meetings shall be held.

<u>Task 5</u>

a. The contractor shall prepare a draft report containing, but not limited to, the following information:

- A draft standard for evaluation and strengthening of existing federally owned and leased buildings, with commentary. The draft standard shall reflect the results of the trial design program, shall consider previously established performance objectives and resolutions of ATC-28 (and other) issues, and shall coordinate with anticipated standards being developed by FEMA for general use.
- Implementation guidelines for the draft standard including, but not limited to, information on using existing (or planned) FEMA documents on seismic evaluation and strengthening techniques.
- An assessment, based on the results of task 2, of existing federal agency programs, indicating which programs exceed and which do not meet the requirements of the draft standard and the recommended implementation procedures.

b. Based on NIST and ICSSC review comments on the draft report, the contractor shall prepare a final report.

Schedule of Deliverables

Task 1 a. Three copies of the initial draft report covering identification of existing and proposed programs, recommendation of performance objectives, and sugeested resolution of issues shall be submitted to NIST no later than six weeks after the contract award date.

b. Within 14 calender days following receipt of NIST and ICSSC comments, three copies of the final report and a floppy disk containing a file (in WordPerfect or other compatible format) of the final report, shall be submitted to NIST.

Task 2 a. Three copies of the initial draft report assessing existing federal programs, identifying rehabilitation criteria, and summarizing standards being developed by FEMA shall be submitted to NIST no later than January 17, 1992.

b. Within 21 calender days following receipt of NIST and ICSSC comments, three copies of the final report and 1 copy of a floppy disk containing a file (in WordPerfect or other compatible format) of the final report, shall be submitted to NIST.

Task 3 a. Three copies of the initial draft trial design plan shall be submitted to NIST no later than January 17, 1992.

b. Within 21 calender days following receipt of NIST and ICSSC comments, three copies of the final plan and 1 copy of a floppy disk containing a file (in WordPerfect or other compatible format) of the final plan, shall be submitted to NIST.

Task 4 a. The first meeting shall not be scheduled later than eight weeks after the contract award date. Minutes shall be provided to NIST and to the panel members within 30 days of the meeting.

b. The second meeting shall not be scheduled later than January 31, 1992. Minutes shall be provided to NIST and to the panel members within 30 days of the meeting.

Task 5 a. Three copies of the initial draft report recommending standards for federal use shall be submitted to NIST no later than February 12, 1993.

b. Within 21 calender days following receipt of NIST and ICSSC comments, three copies of the final report and 1 copy of a floppy disk containing a file (in WordPerfect or other compatible format) of the final report, shall be submitted to NIST.

DETAILED WORK PLAN

The Detailed Work Plan was discussed and finalized at the November 8, 1991 project kick-off meeting. Minutes of that meeting, comments by NIST regarding the minutes and the resulting Master Schedule follow and represent the Detailed Work Plan.

Meeting Report
Date: November 8,1991
Job: NIST Guidelines
Job No: 91101
Subject: Kickoff Meeting

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With: H. S. Lew, Diana Todd - NIST
Ugo Morelli - FEMA
Bill Holmes, Dave Provencher - R & C
Chris Poland, Jim Malley, Jeff Soulages - Degenkolb

Degenkolb

Report:

1. Review History Surrounding the Project

Writing the guidelines for ICSSC through NIST is an important task with major consequences. While the ATC/BSSC effort is six to eight years off, our project must finish in late 1993 so that the President can sign the report in December of 1994. This document will affect all federally owned and leased buildings, all buildings funded by the federal government with grants, and all buildings with loan guarantees. Because our effort will be closely scrutinized by both the technical community and high level policy makers, it must be both thorough and complete. The key issue is the cost implications and thus the trial design program that will identify these costs.

If time were not an issue, ICSSC would rather go through a consensus process like BSSC. ICSSC is made up of 27 agencies. It has a Subcommittee 1 that consists of all the major players and is working to develop these guidelines. Because they are concerned with the final outcome, we must make them feel that they have ownership of the document. The subcommittee is made up of 15 agencies including GSA, DOE, Navy, Army, Air Force, HUD, VA, Dept of State, which collectively own about 90% of all federal buildings. All of our documents will be submitted to the subcommittee for immediate review and quick turn around. The final document will be eventually put before a ballot of the entire ICSSC, then will go to FEMA and finally to OMB.

2. Review Scope of Work

Although FEMA is funding the effort, (Ugo being responsible) it takes up to two months for contracts. For a contractor to get a contract, all the money must be in "escrow," thus safely tucked away. Option 1 (Tasks 2,3, & 4) will come in January 1992. Option 2 (Task 5) will come in December 1992 at the latest. It seemed critical to Diana and Ugo that both Option 1 and 2 be contracted at the same time using money from the '92 budget. It was understood (and later reiterated) that the money for the processing of the Trial Design phase requires separate funding.

A look at the schedule revealed a problem. We were supposed to have started on Tasks 2 & 3 in two weeks. They were to have run concurrently so as to meet the January 17th deadline for Tasks 1,2 & 3. Since we will not receive the notice to proceed for Tasks 2 & 3 till sometime in January, the schedule has been pushed back about one month.

3. Proposed Work Plan

TASK 1 - Identify Programs

When asked about our interview form and whether to do just phone or both phone and personal interviews, H.S. thought it would be better politically to go to Washington D.C. and conduct face-to-face interviews. Also, the peer review process must adequately represent the geographics of the U.S. as well as private industry. Ugo cautioned against looking at buildings not in the U.S. with our criteria. Although he thought we should account for them, they are few in number and he didn't want to complicate our task. H.S. and Ugo suggested a title change to "INTERVIEW TOPICS" to avoid problems with federal laws about questionnaires. Both H.S. and Diana will review the questionnaire and send us comments on Tuesday, as will Bill Holmes.

All agreed on our choices of the four private firms: Kaiser, Hewlett Packard, Stanford University, and TRW. The six federal agencies will be selected after the phone interviews by our team and NIST. We will fax a proposed list to H.S. for discussion before setting up personal interviews. The proper name according to H.S. for our project is "an ICSSC effort to develop standards for evaluating and enhancing federal buildings" otherwise known as public law PL 101 614 section 8A.

After some discussion about including only collected data in the Task 1 Report, Bill suggested that development of the matrix of performance objectives (Task 1C) be moved into Task 2. The Task 1 report should include the following:

- -History and Introduction
- -Summaries of Interviews
- -Matrix of performance objectives (already in use)

We should structure the report as an Executive Summary with all the above included, suitable for distributing to Subcommittee 1 of ICSSC. All supporting documentation, excerpts from agency programs for example, should be put in an Appendix volume. A looseleaf copy of both volumes should be submitted to Diana to aid in reproduction. It is understood that there will be no formal meeting to review draft report comments on Task 1 from NIST. H.S. would like to receive an outline of the Task [illegible] Report no later than December 2, 1991 and the Final Draft Report no later than December 16, 1991.

TASK 2 - Assess Available Programs

Ugo reported that FEMA/BSSC and FEMA/Blume guidelines must be finished by the end of this calendar year. Thus, we should have a final copy to review when we start Task 2. Chris thinks our comparisons of the NEHRP provisions to the other agency provisions will end up being methodology vs. methodology rather than agency vs. agency. He also thinks it would be advantageous to break up the comparisons by building type (using ATC-14/22 classifications). Ugo wanted to make sure the final standards were easy to implement by finding commonalties, emphasizing the central core of each criteria, and keeping the procedures simple. It was agreed that all assessments in Task 2 should be qualitative, including seismic hazard mapping, basic strength and basic ductility. As far as the ASCE/EERC/ATC document is concerned, Ugo wanted to make sure we were both on the same track. Diana said that there should be a formal mechanism in place to let their group know what we were up to and better enable our document to be included in their process.

The Task 2 report should include:

- -Matrix summary of 10 programs
- -Word summary of all 10 programs
- -Statement on family of guidelines to be used in Trial Design process

Ugo again stressed that the NEHRP document must be the basis for our work.

TASK 3 - Trial Design Program

Ugo began by asking what would be a minimum Trial Design Program. As far as amount of money to be spent on the TDP, Ugo said to expect something in the low hundreds. He said we could expect a firm number in mid-January. Bill saw our effort as being two separate programs: 1) renovation being a "trigger" to seismic strengthening and 2) an overall mandated program of evaluation and strengthening for important or life-safety issue buildings. Both Ugo and H.S. wanted our TDP to justify that mandated strengthening is too expensive and that our program should be "affordable." Much discussion was spent on the fact that costs are a tough issue because every building is different and once you start adding in other costs like disruption, asbestos removal, and handicapped upgrades, the costs can vary substantially. H.S. wanted us to stick to structural costs only for the purpose of comparison.

Chris thinks our approach should be to reuse as much information as possible since we have limited funds. We could use the costs for existing projects that have been strengthened and determine how much more/less it would cost to strictly follow the NEHRP provisions. In this way, we would have a better range of costs to which to compare the NEHRP provisions. Both Dames and Moore and VSP have cost data that we might be able to look at. Jim thought we could use the same approach used after Loma Prieta. We could survey engineering firms to determine the costs of strengthening a building and compile the results according to building type to create ranges. Bill asked what the incentive would be for firms to give us data. It is clear that we will have to meet again to discuss Task 3 both in approach and execution.

Bill also brought up the point of the two level earthquake approach and its significance in the eastern and central parts of the United States. The rare, big earthquake needs to be accounted for some way for our program to be worthwhile. Bill feared that if we ignored the problem, we would not be realistic in the types of strengthening required for <u>all</u> parts of the U.S. He wanted to at least have the framework in place in our document so that others (ATC/BSSC effort) could elaborate on it later.

TASK 4 - Panel of Experts

The peer review will serve as our link to the private sector and the technical community. H.S. stressed all reviewers on our panel should come from the private sector and should each represent a major geographical area of the U.S. Although we discussed other people, most of the group agreed on the original list as proposed by Chris:

-Jim Jirsa : University of Texas, Austin
-Alan Porush: Southern Cal - Dames and Moore
-Guy Nordenson: former F/E now with OVR
-Ted Winstead: Memphis
-??? : Ratti Swenson Perbix Clark in Seattle

Other names brought up were : Glen Bell, Stan Lindsey, and Frank McClure. It was decided that the peer review panel would meet twice, once during Option 1 and once during Option 2, and would ballot by mail for the final guidelines.

TASK 5 - Develop Guidelines

It was decided to postpone the discussion of Task 5 until a later meeting.

4. Schedule with NIST

The current schedule may slip one month to the end of February because of funding delays at NIST and FEMA. Currently, the OMB review needs 11 months, the writing of the guidelines needs 3 months and the ICSSC Trial Design needs 6 months. We need to start Option 1 (2,3, & 4) by January 6, 1992 or the Trial Design period gets shorter. We also need the results (draft report) of the Trial Design by December 1, 1992 or the OMB review will get shorter. It was made again clear that compilation of the Trial Design results is not in our outline and that such a task would need a separate contract. Currently, we are required to design the program and write a report covering the program goals and requirements. It was decided that draft outlines for each Task (2,3,4, & 5) would be sent at the halfway point of the time allotted for each task (2 weeks for T2, 4 weeks for T3 & T4, and 6 weeks for T5).

5. Adjourn

IMPORTANT DATES SUMMARY

December 2, 1991	- Outline of Task 1 Report to H.S.
December 16, 1991	- Final Draft Report of Task 1 to H.S.
January 6,1992	- Contract for Option 1 to HJD
Week of Feb. 1992	- Next meeting with NIST and team
December 1,1992	- Contract for Option 2 to HJD

Report by:

Jeffrey R. Soulages

Copies to: All attendees, file

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(301) 975-4032 FAX

Date: December 11, 1991

To: Jim Malley, Degenkolb

From: Diana Todd, NIST DRT

Subject: Meeting Report, Nov. 8 1991 kickoff meeting

I've reviewed the meeting notes you sent me on Nov. 27 and would like to offer the following corrections and clarifications.

1. Review History Surrounding the Project

The standards to be adopted by the President in Dec. 1994 will affect all Federally owned and leased buildings, but will NOT automatically affect buildings funded by Federal grants, lonas, loan guarantees, etc. A report is to be issued along with the standards about how they could possibly be applied to these buildings in the future. The preparation of that report is not part of our contract with you.

The sentence beginning the second paragraph is not accurate. The ICSSC WILL be using a consensus procedure to review and approve the standards that Degenkolb recommends. The ICSSC uses a consensus process similar to that of BSSC, but their membership is only of Federal agencies, and does not include private sector participation as does BSSC. ICSSC Subcommittee 1 will review Degenkolb work products before the final recommendation is submitted to ballot by the full ICSSC.

3. Proposed Work Plan TASK 2 - Assess Available Programs

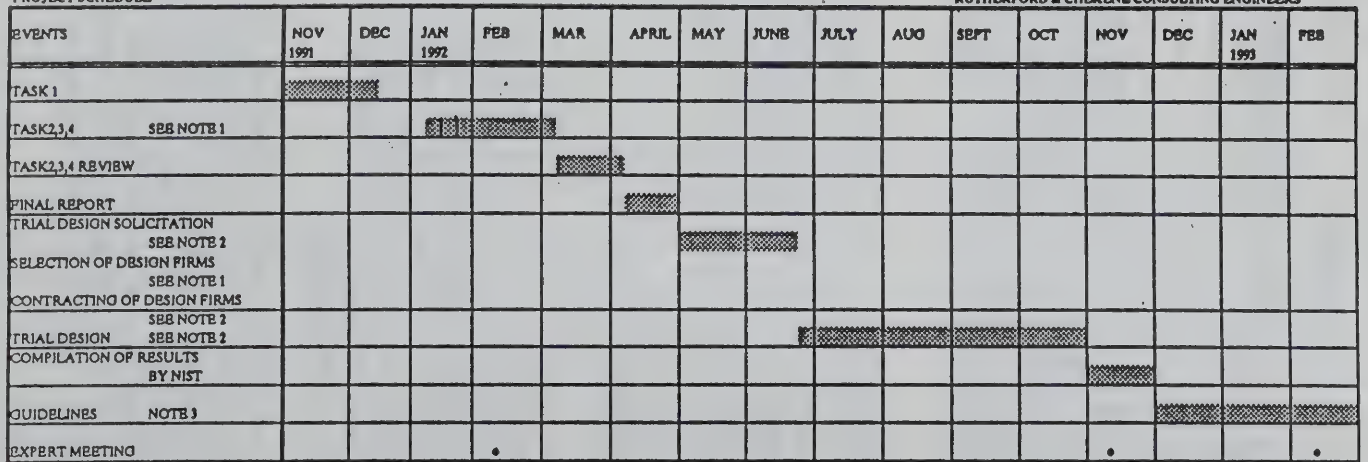
We need to use a common terminology to refer to documents and projects. I assume that when you refer to the ASCE/EERC/ATC document, you mean the BSSC/ATC/ASCE multi-year effort to develop existing building standards similar to the NEHRP Recommended Provisions for new buildings. The last sentence of this section states "Ugo again stressed that the NEHRP document must be the basis for our work." I am not clear about what NEHRP document Ugo was referring to. Was it the NEHRP Recommended Provisions for new buildings? Or was it the BSSC versions of the ATC and Blume studies on existing buildings?

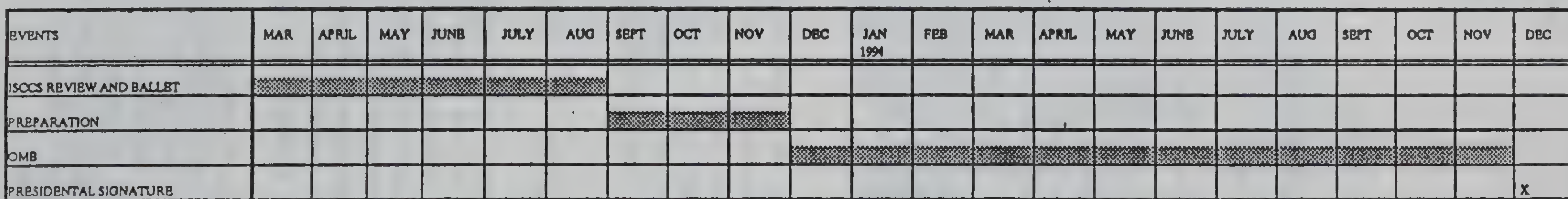
Regarding terminology, I suggest we use "NEHRP Recommended Provisions" or "NEHRP Provisions" to refer to the FEMA/BSSC yellow books for new buildings. Let's use "Evaluation Handbook" for the BSSC consensus version of ATC 22 being prepared for FEMA, and "Techniques Handbook" for the BSSC consensus version of the URS Blume study. I don't have a good suggestion for a short name for the FEMA funded effort by BSSC/ATC/ASCE to develop national consensus standards for existing buildings. I believe the most common name for the expected output of this project is "Guidelines".

copies to: Holmes at Rutherford & Chekene, Morelli at FEMA, Lew at NIST

NIST EVALUATION AND STRENGTHENING GUIDELINES
PROJECT SCHEDULE

H.J. DEGENKOLB ASSOCIATES, ENGINEERS
RUTHERFORD & CHEKENE CONSULTING ENGINEERS





NOTE 1: DELAYS IN START TIME RESULTIN 1:1 SHORTENING OF TRIAL DESIGN TIME

NOTE 2:NOT IN HJD/R&C CONTROL

NOTE 3: DELAY IN START TIME RESULTS IN 1:1 SHORTENING OF ICSSC APPROVAL TIME

Master Schedule
NIST: Federal Guidelines

APPENDIX B

Roster of ICSSC Members and Contacts

October 1991

ICSSC COMMITTEE ON SEISMIC SAFETY IN CONSTRUCTION
FULL COMMITTEE

ADDITIONAL CONTACTS

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APPENDIX C

Rapid Screening and Evaluation Procedures

General Services Administration

Chapter 12: <u>Earthquake Resistance of Buildings</u>

Appendix 12-E: Decision Factor Analysis Procedure

APPENDIX 12-E

DECISION FACTOR ANALYSIS PROCEDURE

The Decision Factor Analysis (DFA) procedure is a simple seismic priority ranking for a series of buildings. The Decision Factor Analysis computes, by means of various indices, a number whose value depends on a number of variables. The variables are classified into four major sub-groups. A building performance factor "P" defines the expected and desired level of performance of the structure in the seismic event. The building location factor "L" depends on the characteristics of the particular site. The seismic event factor "S" characterizes the expected and maximum credible seismic events at the site, and the criteria confidence factor "C" relates to the seismic criteria applicable at the time of construction. After evaluating the various factors, they are combined according to the equation shown below and the sum examined relative to a scale that has been determined for a particular building at a given site.

$$DF = S + P + L + C$$

Definition of Terms in DFA

a. **Building Performance Factor "P"**: (See Fig. 8 and articles (5) through (18) of paragraph entitled "Recommended Ranges of Factor Values For Decision" below.) "P" depends on five variables. The occupancy variable is based on the percentage of time the structure is inhabited by people. The economics variable is the cost of repair and replacement. The construction variable considers the general form of the structural load system and its effectiveness in resisting earthquake excitation forces including the anticipated ductility mobilized. The structural configuration variable indicates geometrical considerations that may influence structural response. The condition variable refers to the overall condition of the force resisting elements of existing structures.

(1) The highest priority group of the occupancy variable includes hospitals and schools with a median group comprising office buildings, Federal courthouses and prisons and multi-family dwellings. The lowest priority group includes warehouses and storage facility structures.

(2) The economics variable considers replacement cost if the structure is entirely destroyed, repair costs for repairing a building and the cost of "down time" when the structure cannot be used during repairs.

(3) The condition variable includes a previous seismic exposure parameter which provides for the effects of accumulated damage throughout the life of the structure to the degree in which this damage might affect the total life span. For example, a building subjected to several moderate earthquakes may have its structural life shortened by 50 percent if the inelastic deformations accumulated in the structure are such that the next moderate earthquake provides the same level of destruction that a more intense event occurring once in the structure's lifetime could produce.

(4) The building structural configuration variable depends on the geometry of the structure. A high degree of symmetry means that stress concentration and torsional effects throughout the structure are less likely to be significant and the dynamic loading may be more uniformly distributed. The more complex the structure, the more of a possibility for problems occurring in the interconnection of different structural elements such as connection of shear walls and frames. Higher buildings, as previously mentioned, have significant contributions to the interstory shear forces from the higher modes, especially near the top. Single mode response procedures, like those of the UBC, would not adequately account for such effects.

(5) The actual construction scheme utilized is the most important consideration affecting the "P" factor. The general construction variable depends primarily on comparisons of historical performance records of similar structures subjected to strong earthquake ground motion. Other construction variables include walls, floors, floor connections, frames and partitions. A major response effect that is influenced by construction variables is the degree of

inelastic deformation that the structural elements can undergo while maintaining sufficient strength to preclude collapse. Although it is mainly a local effect depending primarily on post elastic material behavior, the prevention of a collapse mechanism is strongly influenced by structural configuration and construction variables. These latter variables generally define the order and number of "hinges" required for local or total collapse.

b. **Building Location Factor "L":** (See Fig. 8 and articles (19) and (20) of paragraph entitled "Recommended Ranges of Factor Values For Decision" below.) One parameter affecting the location factor "L" is a stability variable relating to the possibility of local soil failures in earthquakes. Instabilities may be due to local soil failures resulting in slides or grabens as evidenced in the Anchorage 1964 earthquake. The possibility of liquefaction of saturated cohesionless soil may be a significant consideration in some locations although the identification of potential liquefaction generally requires some subsurface investigation. The other parameter influencing "L" relates to the classification of soil types at the site. This parameter can provide an estimate of the potential for soil failure in a strong earthquake. There are several other parameters affecting the location factor but they must be determined based on a more detailed site investigation. Such investigations may only be justified for new construction in high exposure areas. There is uncertainty as to whether the variables are significant in the decision making process. For example, it may be extremely difficult to determine a precise soil failure variable without extensive coring and analysis of the site. However, it is often possible to provide a general estimate of the possibility of gross soil failure by mere inspection of the site.

c. **Seismicity Factor "S":** (See Fig. 8 and articles (1) thru (4) of paragraph entitled "Recommended Ranges of Factor Values For Decision" below.) Three important parameters influencing the seismic exposure of a site are the distance to active faults from which an estimate of the focal distance to possible events can be obtained; the activity of the local faults in terms of the frequencies of occurrence of large and small seismic events; and the magnitude of the DBE for the site. Using historical seismicity and intensity

information available in the literature, and the various empirical relationships relating peak acceleration to magnitude and epicentral distance, the parameters which make up the seismicity factor "S" can be estimated.

d. **Criteria Confidence Factor "C":** (See Fig. 8 and articles (21) thru (25) of paragraph entitled "Recommended Ranges of Factor Values For Decision" below.) When evaluating the appropriate analysis procedure for existing structures, the seismic criteria that were utilized during the time of the construction is used. The criteria confidence factor "C" provides a means of assigning the degree of confidence in a structure using the UBC-recommended lateral force distribution, the material quality in terms of the degree of control required by the code, the effects of torsion on the structural forces and the design detail requirements specified in the UBC (or other applicable code). In general, the age of the structure is the most important consideration in estimating the values of the parameters affecting "C."

Recommended Ranges Of Factor Values For Decision. The purpose of DFA is to quantify the variables involved in establishing a procedure for evaluating existing construction. The following notes provide guidelines for the values to be used in the decision factor analysis of existing construction. The ranges of factor values reflect their relative importance. Linear interpolation is utilized for intermediate values.

a. Parameter values. (See Figure 8)

(1) Distance to Active Faults

Basis: Estimated minimum distance to active fault (in kilometers) which is the source of the postulated DBE

Distance	<10	10	20	40	60	100	200	>200
Parameter Value		15	14	12	10	8	4	2

(2) Magnitude of DBE

Basis: Richter magnitude of postulated DBE

Magnitude	8	7	6	5	4	3	<3
Parameter Value	15	14	12	8	5	2	0

(3) Intensity Index

Basis: Peak Intensity (Modified Mercalli) recorded for the local region (within 100 mile radius)

Modified Mercalli Intensity	VIII	VII	VI	V	IV	<IV
Parameter Value	15	13	10	7	5	0

(4) Activity Index

Basis: Number of historical intensities greater than or equal to Modified Mercalli VI

Number of Events	7-5	3-4	2 or 3	1	0
Index	15	13	10	5	0

(5) Occupancy

Basis: Relative importance of the structure in terms of potential hazard to occupants

Facility	Value
Hospitals	15
Schools	14
Dwellings	13
Prisons	11
Courthouses	9
Post Offices	7
Office Buildings	5
Warehouses	3
Storage Facilities	1

(6) General Construction

Basis: Estimated performance based on observation of similar structures in past major seismic events

Performance	Value
Poor (unreinforced masonry and wood floors)	15
Fair (reinforced concrete frame and masonry walls)	12

Performance	Value
Good (ductile reinforced concrete or steel frame)	7
Excellent (steel frame and reinforced concrete walls)	2

(7) Wall Construction

Basis: Ultimate strength and ductility

Type	Value
Unreinforced Brick	10
Precast Concrete	8
Stucco	6
Poured-in-Place Concrete	4
Metal Panel	2

(8) Floor Construction

Basis: Anticipated integrity of floor-to-wall connections

Type	Value
Wood	4
Concrete Deck	2
Poured-in-Place	1

(9) Floor Connections

Type	Value
Unrestrained	5
Nailed	4
Mortar Grout	3
Bolted	2
Welded	1
Continuous	0

(10) Frame Construction

Basis: Capacity for inelastic deformation with retained strength ductility

Type	Value
Old Concrete Frame (Pre-1960)	10
New Concrete Frame	8
Concrete Shear Walls	6

Type	Value
Structural Steel Old	4
Structural Steel New (Bolted Connections)	2
Structural Steel New (Welded Connections)	0

(11) Partition Construction

Basis: The degree of architectural damage anticipated in the strong seismic event and life-safety hazard due to falling objects

Type	Value
Masonry to Ceiling	10
Masonry to Slab	8
Stucco to Slab	6
Studs to Ceiling	4
Light (Removable)	2

(12) Height

Basis: The characteristics of dynamic response of building structure, importance of higher modes

Height (feet)	>200	150	100	50	20
Parameter Value	15	14	9	6	2

(13) Uniformity

Basis: Percentage of enclosed rectangular plan area occupied by the structure. This parameter relates to the torsional response of the structure and the possibility of concentrating inelastic energy absorption capacity in less stiff elements.

Percentage	20	40	60	80	100
Parameter Value	5	4	3	2	0

(14) Upgrading Costs

Basis: Cost of improving structural performance based on percentage of present date value

Percentage	100	75	50	25
Parameter Value	10	8	5	2

(15) Post Earthquake Repair Costs

Basis: Cost of repairing architectural features of the structure as a percentage of present day cost for new construction

Percentage	100	75	50	25
Parameter Value	20	15	10	5

(16) Down Time

Basis: Relative costs of strengthening or repairing structure in terms of the cost of the unusable building space during construction (monthly lease rate in dollars per square feet)

Lease Rate	1.0	.75	.50	.25	<.25
Parameter Value	10	8	6	4	2

(17) Previous Seismic Exposure

Basis: Cumulative effective of previous strong motions acting on the structure with intensity >VI, uncertainty of fundamental period prediction for degrading material

Number of Exposures	3	2	1	0
Parameter Value	20	12	5	0

(18) Material Deterioration

Basis: Deterioration of structural material with age, loss of inherent ductility

Type	Value
Unreinforced Masonry	10
Unreinforced Concrete	8
Reinforced Masonry	6
Reinforced Concrete	4
Ductile Concrete	2
Steel	0

(19) Site Material

Basis: Possible effects of local soils on characteristics of seismic excitation, amplification of base rock motion

Shear Wave Velocity (feet/second)	<2000	3000	4000	5000	>5000

Parameter Value	10	8	6	4	2

(20) Site Stability

Basis: Possibility of local soil slide failures due to local cuts, fills, or natural slopes (assuming no site borings or logs available)

Description of Site	Value
Terraced side hill w/high water table	10
Poorly drained fill w/unretained local cuts	5
Level Terrain	0

(21) Design Lateral Force

Basis: Magnitude of lateral force to be resisted by structure as specified by previously applicable building codes

Design Condition	Value
Wind	10
0.05 g Acceleration (UBC pre-1961)	5
0.10 g Acceleration (UBC 1970)	0

(22) Lateral Force Distribution

Basis: Shape of equivalent static lateral load distribution

	Value
Rectangular (UBC pre-1961)	5
Triangular (UBC post-1961)	0

(23) Material Quality

Basis: Possible poor concrete because of poor quality control and specification

Concrete Strength	Value
<2000 psi	5
>3000 psi	0

(24) Torsional Effects

Basis: Torsional shear forces specified or not

	Value
Not Included (UBC pre-1961)	5
Included (UBC post-1961)	0

(25) Design Details

Basis: Completeness of specific design details that might enhance ductility of joints

	Value
Incomplete (poor specs)	10
Complete (pre-1970)	0

DFA ITEM	BUILDING LOCATION AGE (Year Constructed) COST (Millions)		PARAMETER VALUE
SEISMICITY FACTOR "S"	Distance to Active Faults [1] Expected Magnitude of DBE [2] Intensity Index [3] Activity Index [4]		
	FACTOR VALUE [26]		
PERFORMANCE FACTOR "P"	Occupancy	Safety Hazard [5]	
	Construction	General [6] Walls [7] Floors [8] Floor Connections [9] Frame [10] Partitions [11]	
	Structural Configuration	Height [12] Uniformity [13]	
	Economics	Upgrading Costs[14] Post Earthquake Repair [15] Down Time [16]	
	Condition	Previous Seismic Exposure [17] Material Deterioration [18]	
	FACTOR VALUE [27]		

Figure 8. Ductility Factors

LOCATION FACTOR "L"	Site Amplification and Stability	Site Material [19] Site Stability [20]
	FACTOR VALUE [28]	
CRITERIA CONFIDENCE FACTOR "C"	Variables	Design Lateral Force [21] Lateral Force Distribution [22] Material Quality [23] Torsional Effects [24] Design Details [25]
	FACTOR VALUE [29]	
	DFA SUM [30]	

Figure 8a (Continued)

SUMMARY
BUILDING: Comments and recommended action:

Figure 8b

Factor Value. Factor value for existing construction shall be applied independently to facilities in a selected geographical area. If several structures are limited to reasonably confined geographical areas, the several values (S, P, L, C) shall be added directly to find the decision factor sum. The use of the same DFA value over widely separated geographical areas is prohibited, since this requires the determination of possibly unreliable weighting factors that would be applied to each of the values (S, P, L, C).

GSA DC-89110027135

United States Coast Guard

MEMO: 15 November 1991

NTSC Seismic Risk Assessment Model

U.S. Department of Transportation

United States Coast Guard

Memorandum

Subject: SEISMIC RISK ASSESSMENT

Date: 15 NOV 1991

11000

From: Chief, Civil Engineering Division

Reply to Attn. of: G-ECV-5A Synowczynski:X-1917

To: Director, Office of Transportation Regulatory Affairs

Ref: (a) G-ECV Memo of 22 Jun 90

1. The preliminary ranking of Coast Guard buildings based on a modified NTSC Seismic Risk Assessment Model has been completed in accordance with reference (a). This preliminary ranking is provided for your information as enclosure (1) and was developed based on the seismic risk factors provided as enclosure (2).

2. It is our intention as discussed in reference (a) to identify for each of the top 100 buildings on the preliminary list, the more detailed framing codes listed in enclosure (3). The seismic risk model will then be rerun using the detailed framing codes to obtain the final ranking for the top 100 buildings.

3. If you have any questions, please call Mr. Stan Synowczynski at 267-1917.

D LEBOFSKY
Acting

Encl: (1) Preliminary Seismic Vulnerablity Ranking of Coast Guard Buildings - September 1991
(2) Seismic Risk Weighing Factors
(3) Structural Framing System Codes

SEISMIC RISK WEIGHING FACTORS

RISK EQUATION

RISK=[(Fs*F)+(Zs*Z)+(Ss*S)+(As*A)+(Is*I)]/(sum of F.W.)

FIXED WEIGHTS (F.W.)		FRAME (Fs)	
FRAME (F)	100	URM	100
ZONE (Z)	80	RM	40
STAFF (S)	50	UC	60
AGE (A)	40	RC	50
IMPORTANCE (I)	25	STEEL	50
SUM	295	WOOD	40

STAFF (Ss)		AGE(As)	
100+	100	Pre1945	100
50-99	60	Pre1950	90
25-49	30	Pre1960	80
10-24	20	Pre1970	70
0-9	5	Pre1982	60
		Post1982	10

ZONE (Zs)		IMPORTANCE (Is)	
7	100	Most	4
6	80		3
5	70		2
4	50	Least	1
3	40		
2	20		
1	10		

ENCLOSURE(2)

IMPORTANCE CATEGORIES USED IN SEISMIC RISK MODEL

	USE CODE	SUB-CODE
IMPORTANCE = 4		
Communications Buildings	131	all
Lighthouses	137	20-23
Loran C Bldgs	137	35-38
Aircraft Operational Hangars/bldgs	141	all
Multi-Mission Stations	143	80
Waterfront Operational Bldgs	159	64
Admin/Ops Office Bldgs	610	10
IMPORTANCE = 3		
Aircraft Maintenance Shops	211	all
Boat Maintenance Shops	213	80-85
Electronic/Elect Maintenance Bldgs	217	10
Industrial Maintenance Shops	218	all
General Purpose Warehouse	441	10
Inventory Control Point	461	10
Hospitals	510	10
Medical/Dental Bldgs	520	all
IMPORTANCE = 2		
Training Buildings	171	all
Facility Engineering Shops	219	10
Enlisted UPH Barracks	721	10
Enlisted/Officer Dining Facility	722	all
Officers UPH Barrack	724	all
IMPORTANCE = 1		
NAFA Facilities	740	all
Personnel Support Services	730	all
Family Housing Apartment Bldg	711	10
Community Center	714	all

STRUCTURAL FRAMING SYSTEM CODES

FRAME CODE	FRAMING SYSTEM TYPES
	<u>BEARING WALL SYSTEM (Figures A,B,C and D)</u>
1	Light framed walls with shear panels
2	Reinforced concrete shear walls
3	Concentrically braced frames
4	Reinforced masonry shear walls
5	Unreinforced masonry shear walls
	<u>BUILDING FRAME SYSTEM (Figures E,F,G,H and L)</u>
6	Eccentrically braced frames
7	Light-framed walls with shear panels
8	Reinforced concrete shear walls
9	Concentrically braced frames
10	Reinforced masonry shear walls
11	Wood frames
12	Unreinforced masonry shear walls
	<u>MOMENT RESISTING FRAME SYSTEM (Figure I,J and L)</u>
13	Special moment frames of steel
14	Special moment frames of reinforced concrete
15	Braced wood frames
16	Ordinary moment frames of steel
17	Intermediate moment frames of reinforced concrete
18	Ordinary moment frames of reinforced concrete

Department of the Navy

NAVFAC P-355.2

Appendix D: Summary of the Rapid Seismic Analysis Procedure

APPENDIX D

SUMMARY OF THE RAPID SEISMIC ANALYSIS PROCEDURE

D-1. Introduction

This appendix summarizes the rapid seismic analysis procedure (RSAP) developed by the Naval Civil Engineering Laboratory (NCEL) for the Naval Facilities Engineering Command (NAVFACENGCOM). The RSAP is preceded by computer and on-site screening at which time site hazards are identified. The RSAP is intended to identify buildings that are either liable to be severely damaged or only lightly damaged. It is a further screening tool. A complete description of this procedure is given in the NCEL Technical Memorandums TM No. 51-78-02 and TM No. 51-83-07. Examples showing the analysis of a steel and a concrete building are given in paragraph D-9.

D-2. Background

The RSAP was initially developed by John A. Blume & Associates in a pilot study of a relatively large number of buildings at Puget Sound Naval Shipyard in 1973. The procedure was formalized by NCEL.

a. Seismic investigation of an activity. The seismic investigation is divided into two phases. In Phase I the selected buildings at the activity are analyzed approximately by RSAP. Phase I parallels chapters 2, 3, and 4 of this manual. Those buildings found to be inadequate to Phase I are analyzed in detail in Phase II to determine the degree of strengthening required and to estimate costs of upgrading. Phase II parallels chapters 5, 6, and 7 of this manual.

b. RSAP. The main purpose of the RSAP is to identify those buildings that may be susceptible to severe damage. The major steps of the RSAP are shown in table D-1. The procedure has the same development roots as the procedures covered by chapters 2, 3, and 4 of this manual. The major modifications that NCEL made to the basic rapid analysis procedure follow:

(1) Systemization of the analysis of the facility inventory assets at a Naval installation.

(2) Development of the response spectra for the design earthquakes. This procedure has since been formalized by the Tri Services Committee and is covered by NAVFAC P-355.1 (e.g., SDG).

(3) Automation of computation of shear stiffnesses for concrete or masonry buildings, the first mode shape and natural period of multi-story buildings, and estimation of building damage from the response spectra.

(4) Enhance the RSAP with the following modifications:

(*a*) Criteria for field screening.

(*b*) Criteria for eliminating buildings from further investigation in the rapid analysis.

(*c*) Modified criteria for determining structural properties including damping values, natural periods and base shear capacities.

(*d*) Modified criteria for determining the site demand from the response spectra at the ultimate base shear capacity for certain systems.

(*e*) Criteria to aid the selection of buildings for detailed analysis.

(*f*) Criteria to aid in evaluating the adequacy of the lifeline utilities at a given Naval activity.

D-3. Selection of buildings

The selection procedures of the RSAP includes provisions for inventory reduction, field screening, gathering of structural drawings and calculations, a visual inspection of the selection buildings, and a cursory survey of the site geological hazards.

a. Inventory reduction. A procedure and criteria are presented in the RSAP references to facilitate the selection of the buildings for the visual screening. With the issue of this manual, the RSAP criteria are superseded by the screening procedure of paragraph 2-3 of this manual.

b. Field screening. The RSAP references recommend criteria for eliminating buildings from further investigation. These decisions are made after the brief survey to determine physical conditions and after a brief examination of construction drawings. The criteria are similar to those provided in paragraph 3-2 of this manual.

c. Visual inspection of selecting buildings. A final visit is made to verify that buildings are built as shown on the drawings, especially the lateral-force resisting elements. This step of the RSAP is similar to the first two steps of the preliminary evaluation described in paragraphs 4-2*a* and 4-2*b* of this manual.

d. Site geological hazards. During the site visits, a cursory survey should be made of the potential seismically-induced geological hazards based on the available geologic subsurface information. These hazards include faults and fault rupture, liquefaction, landslide and lateral spreading, ground cracking, compaction settlement, tsunami, and seiches.

Table D-1. Major steps of the Rapid Seismic Analysis Procedure (RSAP)

Preliminary

- Visual survey of the lifeline utility system.
- Screening.
- Selection of buildings.

RSAP

- Determination of the site elastic response spectra.
- Determination of the structural properties at yield and ultimate levels for the transverse and longitudinal directions.
- Estimation of damage from the structural capacities and demands from the response spectra.

Follow-Up

- Selection of buildings for detailed analysis.
- Follow-up investigation of site hazards.

D-4. Determination of response spectra

Site specific elastic response spectra for single degree-of-freedom systems are determined in accordance with the procedures given in the SDG, chapter 3, appendix C and appendix D. The NAVFAC ground motion criterion for the RSAP is a maximum ground acceleration having a 20 percent probability of exceedence in 50 years. (Note, this differs from the provisions in this manual, which specifies EQ-II. EQ-II has a 10 percent probability of not being exceeded in 100 years.)

a. Sample response spectra. Figure D-1 shows the resulting response spectra for an intermediate soil site with a maximum ground acceleration of 0.25g. The curves in the figure are used for determining the seismic demands (loading) on the buildings. These spectra are used for the examples of the RSAP given in paragraph D-9.

b. Acceptable capacities. Buildings with spectra acceleration capacities at ultimate that satisfy the site demands at ultimate according to the ground motion criterion are considered fully acceptable. Those buildings whose spectral acceleration capacities at ultimate are 75 percent of the demands at ultimate are considered marginal.

c. Variation in force levels. It is recommended that damage estimates be made for a few force levels below and above the 80 percent/50 year level. These estimates provide a profile of the expected seismic response of the building. This recommendation is similar to those in paragraph 4-2*d*(6) of this manual.

D-5. Determination of structural properties at yield and ultimate levels

The damping values, the natural periods, and the base shear capacities are determined for the transverse and longitudinal directions of the building.

a. Damping values. The assumed damping values used in the RSAP are given in table D-2.

Table D-2. Damping values

Type	Percent of Critical Yield	Ultimate
Steel	5	10
Concrete	5	10
Wood	10	20
Masonry	5	10

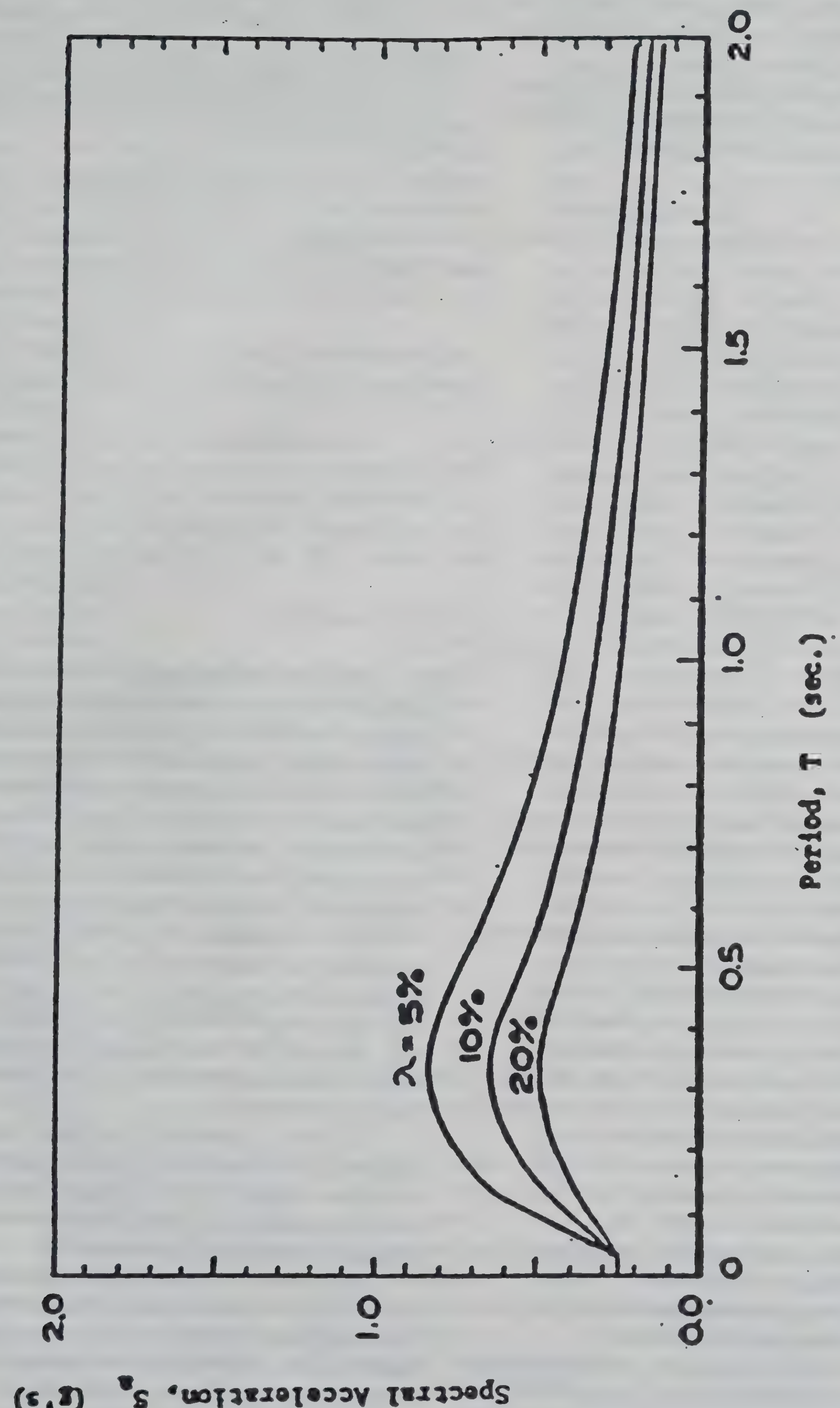


Figure D-1. Site response spectra for a Naval activity in southern California

(Note, these vary from the values given in table 4–2 of this manual.) The damping value increases from the yield to the ultimate level due to the inelastic deformation of the structural and non-structural elements of the building.

b. Natural periods. Natural periods of the building in the transverse and longitudinal directions are determined from the following equations:

(1) Yield Level:

$$\text{Empirical: } T_Y = C\left(\frac{0.05\, h_n}{\sqrt{D}}\right) \quad \text{(eq D–1)}$$

$$\text{Theoretical: } T_Y = 2\pi\sqrt{\frac{m}{k}} \quad \text{(eq D–2)}$$

$$T_Y = 2\pi \, \frac{\sum_{i=1}^{n} w_i \delta^2}{g \sum_{i=1}^{n} f_i \delta_i} \quad \text{(eq D–3)}$$

(2) Ultimate Level:

$$T_U = T_Y \sqrt{\mu \, \frac{S'_{aY}}{S'_{aU}}} \quad \text{(eq D–4)}$$

where h_n = height of building (ft)

D = width of building in the direction considered (ft)

C = a constant between 0.75 and 1.5 to account for building mass and stiffness

m = seismic mass

k = stiffness of the building in the direction considered

w_i = weight of the building at level "i"

δ_i = elastic deformation at level "i" using the applied lateral forces f_i

f_i = approximate lateral force distribution consistent with the assumed fundamental mode shape

μ = ductility factor equal to ratio of maximum displacement to yield displacement

S_{aY} = spectral acceleration capacity of the building at yield level

S_{aU} = spectral acceleration capacity of the building at ultimate level

(3) Equation D–1 is obtained by multiplying equation 3–3A of NAVFAC P–355 (e.g., BDM) by the constant C to account for the different building masses and stiffnesses. Equation D–2 is the natural period for a single degree-of-freedom system.

(4) Equation D–3 is the Rayleigh equation 3–3 of the BDM. The weight of the building is approximated by assuming unit weights for the roof framing, floor framing, wall, actual live loads (if any), and other miscellaneous items.

(5) The natural periods of the building at the ultimate level, T_U, are computed from the periods at the yield level, T_Y, by using equation D–4. The range of the recommended ductility factors, μ, are given in table D–3.

Table D–3. Ductility factors

Type	μ
Steel	4–6
Concrete	3–4
Wood	3–4
Masonry	2–3

c. Base shear capacities. After reviewing the field survey notes and the construction drawings, rought sketches of typical plans and elevations of each building are made to determine the primary lateral-force resisting system or systems. The yield and ultimate base shear capacities of a building are computed by summing the contributions from the vertical lateral force-resisting elements of the building in the transverse and longitudinal directions and dividing the results by the seismic weight of the building. The horizontal lateral-force resisting elements such as beam, girders, floor and roof diaphragms are only considered indirectly in the analysis by examining the effectiveness of their connections to the vertical lateral-force resisting elements.

(1) *Yield capacity.* The yield capacity of a building is defined as the lateral-force required to cause the significant yielding of the most critical, not necessarily the most rigid, component of the lateral-force resisting system.

(2) *Ultimate capacity.* The ultimate capacity of a building is defined as the lateral-force required to cause yield initiation of the most flexible component of the lateral-force resisting system of the formation of a collapse mechanism.

(3) *Examples.*

(*a*) A steel building with a lateral-force resisting system consisting of infill brick walls and X-braces may behave as follows in resisting seismic forces. The brick wall and X-braces may act

together in resisting the seismic forces until cracking of the brick wall is initiated. Then the X-bracing and columns (only after the yielding of the X-braces) will take more and more of the seismic loading until they fail.

(*b*) For a reinforced concrete building with shear walls, the shear walls will resist most of the seismic loading until they have started to crack. Thereafter, the frames will start to resist on increasing portion of the loading. For reinforced concrete frame and/or shear wall and reinforced masonry buildings, the ultimate base shear capacity, C_{BU}, is computed first. Then, the yield base shear capacity, C_{BY}, is obtained by dividing C_{BU} by a load factor 1.5.

(*c*) Wooden frame buildings with shear panels will behave like the concrete frame and shear wall buildings.

d. Spectral acceleration capacities.

(1) Before they can be used for estimating the earthquake damage, the base shear capacities C_{BY} and C_{BU} must be transformed to the spectral acceleration capacities S'_{aY} and S'_{aU} using the following equations:

$$S'_{aY} = \alpha\, C_{BY} \qquad \text{(eq D-5)}$$

$$S'_{aU} = \alpha\, C_{BU} \qquad \text{(eq D-6)}$$

(2) The constant α in the equations depends on the mode shape and mass distribution. The great majority of the Navy buildings are less than three stories high and can be classified as low-rise ($\leq$ 6-story). The α constant for low-rise buildings ranges between 1.05 and 1.18, with the larger value for the taller buildings. For conservatism and simplicity, α is assumed to be one in most cases. (Note, α as used in this appendix is the inverse of α used in the SDG and in table 4-1 of this manual.)

D-6. Estimate of damage

Earthquake damage is estimated from the demands of the response spectra using the damping values, natural periods, and spectral acceleration capacities of the building.

a. Damage assumption. Until yield capacity of the building is reached, damage is assumed to be equal to zero and ductility factor equal to one. When the ultimate capacity is reached, damage is assumed to be equal to 100 percent and ductility factor equal to the maximum value. For intermediate values of capacity, damage assessment is necessarily somewhat subjective and depends on many factors not amenable to analytical treatment. For the rapid analysis, damage is assumed to vary linearly between the yield capacity, S'_{aY}, and the ultimate capacity, S'_{aU}, as shown in figure D-2.

b. Damping assumption. Another assumption required for estimating damage is the amount of damping during the response of the building. Damping is assumed to be a constant up to the yield capacity. Above yield, the damping increases because of energy absorption and dissipation from inelastic response. The damping values used in the rapid analysis were given in table D-2. Furthermore, damping is assumed to vary linearly between the yield and ultimate capacities of the building.

c. Damage estimating procedure. The procedure for estimating damage is based on the reconciliation of the site demands, S_{aY} and S_{aU}, and the spectral acceleration capacities of the building, S'_{aY} and S'_{aU}. The procedure is illustrated graphically in figure D-2. The spectral acceleration capacities of the building are denoted by the open circles at the natural periods shown. The corresponding site demands are denoted by the black dots. The intersection of the two lines defined by the two sets of points determines the estimated damage of 60 percent. This procedure is essentially the same as the capacity spectrum method of the SDG that is described in paragraph 4-2*d* of this manual.

d. Modification to damage estimation procedure. After performing the rapid seismic analysis on a fairly large number of steel buildings and wooden buildings, comparisons of the RSAP damage estimates with damage observed in major earthquakes for buildings of similar construction indicated that the estimated damage were much higher than the observed. More realistic damage estimates were obtained by applying a reduction factor R_U to the ultimate site demands for steel, wooden, and reinforced concrete and reinforced masonry buildings with better-than-average reinforcement detailing.

(1) The reduction factor R_U is used to account for energy absorption and dissipation from inelastic seismic response of the building during actual earthquakes not accounted for by the lengthening of the natural periods and increase in damping from the yield to the ultimate level. The following R_U values are recommended:

(*a*) Steel Buildings: $R_U = 5.0$.

(*b*) Wooden Buildings: $R_U = 5.0$ for those buildings with a large number of interior partitions. For wooden warehouses and large-span wooden structures, $R_U = 1.5$.

(*c*) Reinforced Concrete and Masonry Buildings: $R_U = 1.5$ for those buildings with better-than-average detailing than required by code during their design. Otherwise, $R_U = 1.0$.

(2) An illustration of the effect of R_U on the estimated damage is shown in figure D-2. With R_U of 5.0, the estimated damage is reduced from 60 percent to 34.4 percent.

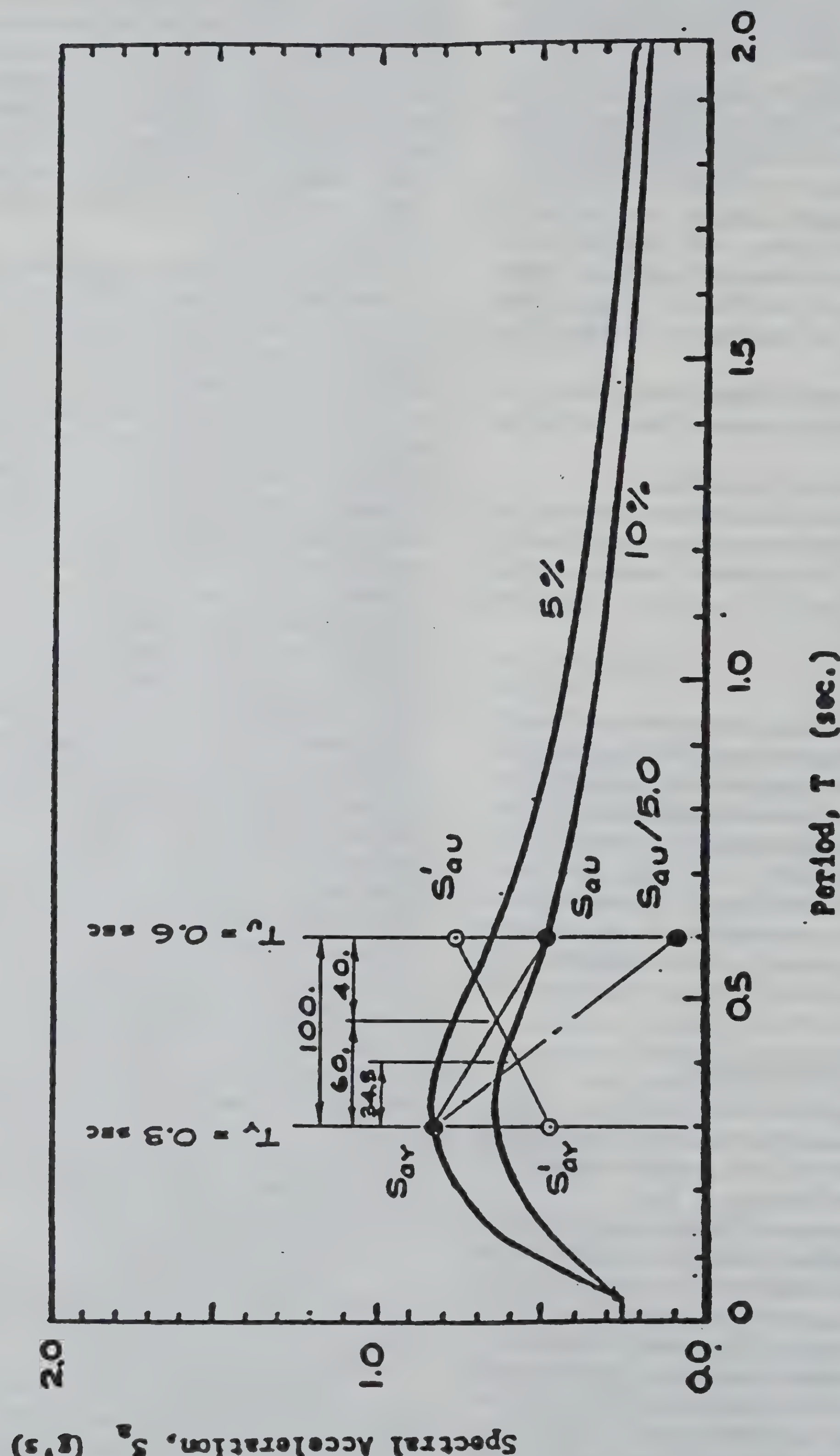


Figure D-2. Graphical illustration of damage estimation

e. Combined building damage estimate. For each building, damage is computed for the transverse and longitudinal directions. To determine the combined damage for the building, it is assumed that one-third of the building depends on the lateral-force resisting system in each principal direction and one-third depends on both directions. That is, if a lateral-force resisting element required to provide seismic resistance in both directions is damaged by earthquake ground shaking in one direction, it is also damaged in the other direction. Combined damage for the building is obtained by taking two-thirds of the damage in the more critical direction and adding one-third of the damage in the other direction. For instance, if the damages are 60 percent and 30 percent in the transverse and longitudinal directions, the combined damage is 50 percent. (Note, this is essentially the same as paragraph 4–2*d*(5) of this manual.)

f. Computer aided procedure for damage estimates. When computing damage estimates for many buildings and/or at many different ground acceleration levels, the computation is best done by a computer program. NCEL has developed computer program CEL ·9 to do the calculations. The site identification, maximum site ground acceleration, digitized site response spectra, building identification, damping values, natural periods, and spectral acceleration capacities at the yield and ultimate levels for the transverse and longitudinal directions, and the replacement cost are input into the computer. The program computes the estimates damage and cost for the building at the maximum site ground acceleration. The damage cost is obtained by multiplying the estimated percent damage by the replacement cost. In addition, the program computes damage estimates for maximum ground accelerations between 0.05 and 0.50g at 0.05g increments. A sample output from the program for a steel building is given in table D–4.

g. In general, the successful application of the rapid seismic analysis procedure demands experience in seismic design and construction and good engineering judgment.

D–7. Selection of buildings for detailed analysis

Based on the results from the rapid analysis, the following guidelines are used in selecting buildings for detail analysis:

a. Buildings with greater than or equal to 60 percent combined damage under the maximum site ground acceleration would definitely require detail analysis.

b. Buildings with greater than 30 percent combined damage may warrant detail analysis.

c. Buildings with relatively poor structural connections may require detail analysis, even if the combined damage is less than 30 percent.

d. Essential buildings and other structures that are required to remain functional during and after a major earthquake are analyzed in detail as for new buildings according to the criteria given in NAVFAC P–355.1 (e.g., SDG). Variance from the criteria is allowed only with the consent of the approving authority.

D–8. Visual survey of lifeline utilities

If an activity is to remain functional before and after an earthquake, the lifeline utility systems and the mechanical and electrical equipment must also remain functional. As a part of the rapid seismic analysis, a cursory survey is made of the lifeline utility system to determine its adequacy. The lifeline utility system at an activity includes:

- Energy
- Water
- Sewer
- Communication
- Transportation

a. Network of utility elements. The effects from the failure of an utility element of the lifeline utility system is different than the failure of a building in an activity with many buildings. The failure of a building generally has little or no effect on the surrounding buildings, except in case of fire. By contrast, the utility elements are part of a network. The failure of one element can have an immediate effect on the function of the whole network. A discussion of lifeline utility problems in past earthquakes and solutions is given in NCEL TM No. 51–83–07.

b. Administrative measures. The following administrative measures are recommended to minimize effects from earthquake damage to lifeline utilities on the mission of an activity:

(1) Analyze and strengthen inadequate structures.

(2) Provide adequate seismic bracing and/or anchorage to utility equipment and storage facilities (see chapters 3 and 10 of the BDM and chapter 6 of the SDG for examples).

(3) Provides standby emergency power, water, materials, storage facilities, and alternative utility routes to insure rapid restoration capacity.

(4) Develop disaster recovery strategies.

(5) Coordinate emergency planning with other military activities.

Table D-4. Sample output of damage estimate for a steel building from computer program CEL 9

DAMAGE ESTIMATES FOR VARIOUS LEVELS OF EARTHQUAKE

DAMAGE ESTIMATE FOR VARIOUS BUILDINGS AT NSY LONG BEACH

BLDG 132 MACHINE TOOL AND ELECTRO SHOP

BUILDING PROPERTIES AND DAMAGE ESTIMATE FOR A NOMINAL ACCELERATION OF $\boxed{0.25\ G}$

	PERIOD (SEC)	DAMPING	SA STR CAPACITY (G)	SA SITE DEMAND (G)	R
TRANSVERSE DIRECTION					
YIELD LEVEL	2.430	0.05	0.130	0.169	
ULTIMATE LEVEL	3.640	0.10	0.160	0.002	5.000
LONGITUDINAL DIRECTION					
YIELD LEVEL	0.620	0.05	0.150	0.628	
ULTIMATE LEVEL	1.240	0.10	0.170	0.053	5.000

BUILDING REPLACEMENT COST $ 17250000.

ESTIMATED TOTAL DAMAGE TO BUILDING 60.1 PERCENT

ESTIMATED COST OF DAMAGE $ 10380682.

DAMAGE ESTIMATES FOR VARIOUS LEVELS OF MAXIMUM GROUND ACCELERATIONS

	TRANSVERSE DIRECTION			LONGITUDINAL DIRECTION				
	SPECTRAL ACCEL			SPECTRAL ACCEL				
MAX GRND ACCL. G	YIELD G	ULT. G	DAMAGE PCNT	YIELD G	ULT. G	DAMAGE PCNT	COMBINED DAMAGE PCNT	DAMAGE EST 1000 $
0.14	0.095	0.001	0.0	0.352	0.030	59.0	39.3	6785
0.19	0.128	0.001	0.0	0.477	0.040	71.6	47.7	8240
0.25	0.169	0.002	19.8	0.628	0.053	80.3	60.1	10380
0.05	0.034	0.000	0.0	0.126	0.011	0.0	0.0	0
0.10	0.068	0.001	0.0	0.251	0.021	40.5	27.0	4657
0.15	0.101	0.001	0.0	0.377	0.032	62.1	41.4	7149
0.20	0.135	0.001	3.2	0.502	0.042	73.4	50.0	8630
0.25	0.169	0.002	19.8	0.628	0.053	80.3	60.1	10380
0.30	0.203	0.002	31.5	0.754	0.064	85.0	67.2	11596
0.35	0.237	0.002	40.3	0.879	0.074	88.4	72.4	12490
0.40	0.270	0.003	47.1	1.005	0.085	90.9	76.3	13175
0.45	0.304	0.003	52.6	1.130	0.095	92.9	79.5	13717
0.50	0.338	0.003	57.0	1.256	0.106	94.5	82.0	14157

United States Postal Service

ATC-26-1

Chapter 2: Inventory Screening and Prioritization

Appendix A: USPS Facility Inventory Database

2. Inventory Screening and Prioritization

2.1 Introduction

2.1.1 General

This chapter deals with procedures for screening facilities in the USPS inventory to identify facilities requiring differing levels of seismic evaluation. Facilities meeting certain screening parameters will be grouped together to identify: (a) buildings that might be susceptible to structural damage and/or collapse, and (b) facilities that possess nonstructural components that could pose life-safety risks. The screening process also helps to reduce the number of facilities evaluated in the seismic program by excluding buildings that meet minimum seismic safety criteria.

This publication provides a general framework for a screening process that eliminates unnecessary evaluations and identifies buildings requiring further evaluation. These guidelines address both structural and nonstructural seismic evaluations and have been adapted to the requirements of the USPS.

2.1.2 Reference Documents

These evaluation procedures are based on guidelines that were developed by the Interagency Committee on Seismic Safety in Construction (ICSSC, 1988). The recommended primary reference document for the procedures described in this document is ATC-22 (ATC, 1989). This document contains the basic methodology employed in the preliminary seismic evaluations.

2.2 Inventory Screening Procedure

The inventory screening process uses information contained in the Facilities Management System (FMS) and is supplemented by a questionnaire. The FMS database consists of over 35,500 separate entries describing each facility in terms of type of quarters, construction material, area, location, and date of occupancy by the USPS. Appendix A provides background information on the FMS database. A questionnaire, a sample of which is found in Appendix B, should be used to verify the information contained in the FMS database before the actual screening.

Questionnaires for each facility should be generated using the FMS and distributed to the Division Level for completion. The information requested in the questionnaire needs to follow the format adopted for screening the facilities confirming data such as county, type of construction, building area, and number of stories. In most cases the information may be confirmed by telephoning the Facility Manager. The purpose of the questionnaire is to provide the minimum level of information required for the inventory screening. Once the completed questionnaires have been collected, a revised database should be prepared for the actual inventory screening.

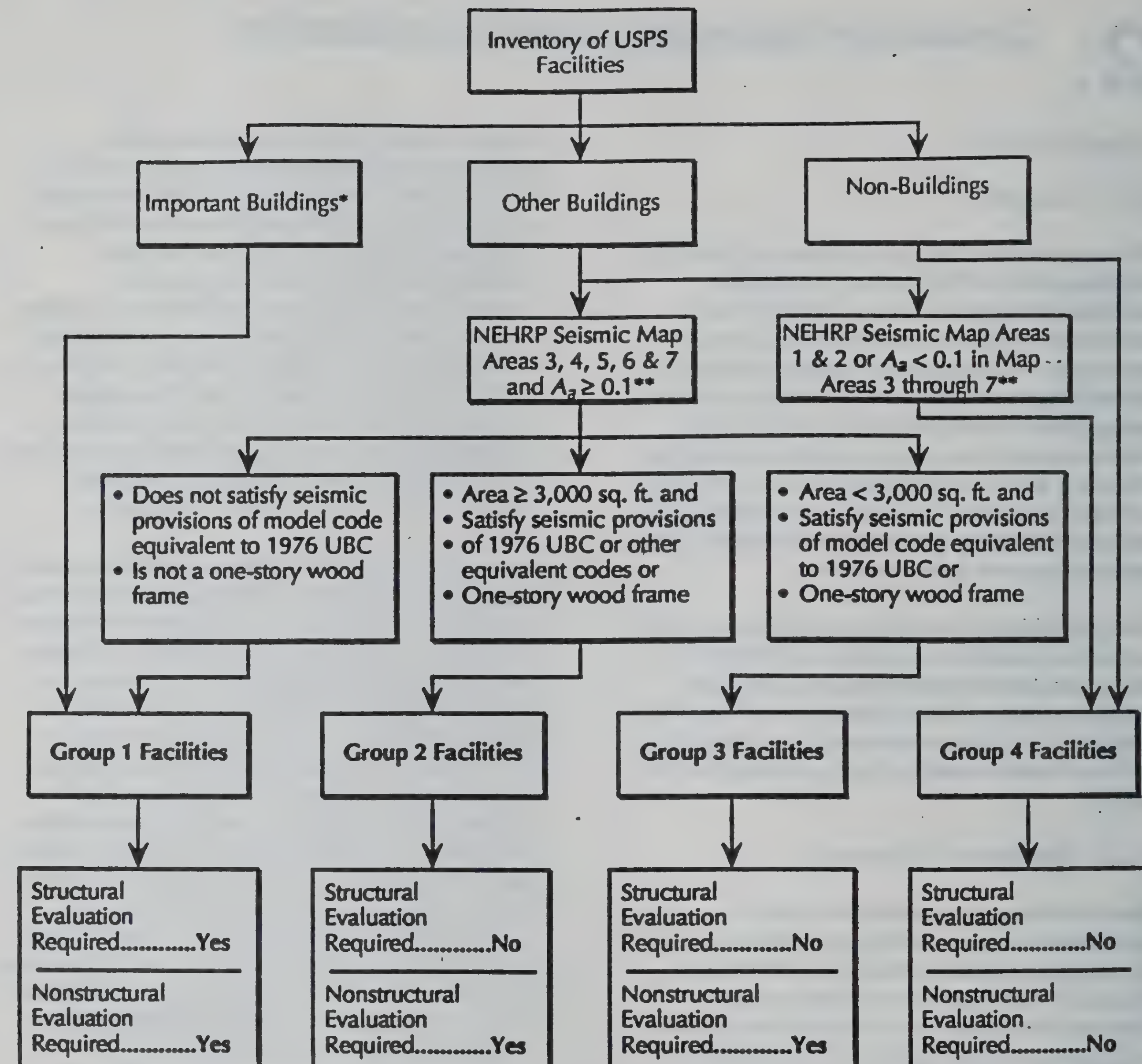
One of the important criteria used in the inventory screening is seismicity. Throughout this document, seismicity is described in terms of an acceleration coefficient, A_a, and a velocity-related acceleration coefficient, A_v. The coefficients vary throughout the United States, being higher in areas of high seismicity and lower in areas of low seismicity. Only A_a values are used in the screening process. A_a coefficients are provided on Maps A and B (pocket insert, inside back cover), which contain maximum A_a coefficients by county (Map A) and contours of A_a throughout the United States (Map B). The way in which these maps are used is explained in the following section. Since Maps A and B were initially used in 1978, new information has become available that suggests A_a values need to be modified in certain areas. Recommended modifications are provided in Table 4-3.

The following section describes the screening criteria and identifies the facility groupings. The screening should identify buildings in each group so that plans to implement the Evaluation Phase could be formulated.

2.3 Facility Grouping and Screening Criteria

2.3.1 General

The inventory screening procedure assigns each USPS facility to one of four groups. The type of seismic evaluation required for each facility is thereby specified. The screening process is presented in Figure 2-1.



* Defined by the USPS as being particularly important to the continued operation of the Postal Service. See Section 2.3.1

** Use Map B and Table 4-3 for determining A_a.

Figure 2-1 Screening process

Group 1 facilities require both structural and nonstructural evaluations. Groups 2 and 3 require nonstructural evaluations but not structural evaluations. The difference between Group 2 and Group 3 evaluations is the minimum qualification level of the evaluators. (Section 5.2 describes the evaluator qualifications required.) Group 4 facilities do not require either structural or nonstructural evaluations. Table 2-1 summarizes the facility groupings.

Certain facilities may be defined by the USPS as being particularly important to the continued operation of the Postal Service. Such facilities, designated as Important, are those that have highest priority for postearthquake operational capability. Regardless of the screening protocol, this small number of Important Facilities should receive both a structural and nonstructural evaluation. Important Facilities, for example, might include certain:

USPS Headquarters
USPS Regional Offices
USPS Field Division Offices
Bulk Mail Centers
Postal Data Centers
General Mail Facilities
Airport Mail Facilities

2.3.2 Group 4 Facilities

Group 4 excludes Important Facilities; it contains all facilities in NEHRP Seismic Map Areas 1 and 2 (Map A) and in other areas where $A_a < 0.1$ (Map B, Table 4-3). This group is estimated to represent approximately two-thirds of all USPS facilities. It also includes USPS facilities that are not buildings, such as:

Self-service Postal Centers
Land Only
Vacant Facilities
Facilities Out-leased
Parking—Land Only
Unattended Post Office Boxes

Group 4 facilities do not require structural or nonstructural evaluations.

2.3.3 Group 3 Facilities

Group 3 contains all facilities except Important Facilities in USPS Map Areas 3 through 7 (Map A) for which $A_a \geq 0.1$ (Map B, Table 4-3), with floor areas less than 3,000 square feet; that meet one or more of the following criteria:

Facilities designed according to the seismic provisions of the *1976 Uniform Building Code* (International Conference of Building Officials, 1976) or other equivalent codes acceptable to the USPS.

Facilities that are one-story wood frame structures.

Table 2-1 Seismic Evaluation Required?

Facility	*Seismic Structural Evaluation Required*	*Seismic Nonstructural Evaluation Required*
Group 1	YES	YES
Group 2	NO	YES
Group 3	NO	YES
Group 4	NO	NO

Group 3 facilities are exempted from a structural evaluation but require a nonstructural evaluation. The structural exemption is granted based on past experience with certain building types that perform acceptably during earthquakes, by virtue of particularly low seismicity, construction according to recognized building code standards or characteristics inherent in the construction materials.

2.3.4 Group 2 Facilities

Group 2 facilities meet the same criteria as Group 3 facilities except they have floor areas greater than or equal to 3,000 square feet. These facilities also will require only a nonstructural evaluation, but in this case more stringent evaluation qualifications are required (see Section 5.2).

2.3.5 Group 1 Facilities

Group 1 contains the remaining facilities not previously identified and is estimated to contain approximately one-quarter of all USPS facilities. Group 1 also includes all Important Facilities, which have been designated by the USPS to receive seismic evaluations regardless of the group to which they would normally belong. Group 1 facilities require both structural and nonstructural seismic evaluations.

Appendix A: USPS Facility Inventory Database

The FMS Database

The currently existing 35,528 USPS buildings are listed in a USPS database that is known as the Facilities Management System (FMS). There is a database record for each building, and each record (building) has a number of fields. The fields of interest are:

- Post office name
- State
- Unit name
- Street address
- ZIP code
- County
- Elevators
- Interior square feet
- Date of first occupancy
- Type of quarters (the use of the building)
- Type of construction
- Leased or owned

Seismic Program Databases

The ATC-26 Database

The primary program database, called "the ATC-26 Database," is the FMS database modified by adding a NEHRP Seismic Map Area number and deleting all FMS fields irrelevant to the program. The NEHRP Provisions (BSSC, 1988) divide the 50 states into seismic map areas using the acceleration coefficients A_a and A_v (ATC 3-06). The map for the acceleration coefficient A_a was chosen as more relevant than the map for the coefficient A_v because A_a governs the limiting value that applies to buildings in the short-period range, which includes the majority of USPS buildings. The map is subdivided into Seismic Map Areas comprised of counties that are characterized by one of seven levels of seismicity. The Seismic Map Area number for each county was entered into the database for the USPS buildings in that county to produce the ATC-26 database.

The Sample Survey Database

The secondary database, the Sample Survey Database (SSDB), was developed to illustrate how the ATC-26 procedures should be used to evaluate existing USPS buildings. It is a set of 200 records obtained from the ATC-26 database in the following manner. First, the criteria for building selection were set down. In the SSDB, the buildings designated were in two basic groups: the most numerous and the most special USPS buildings. The list was further refined by designating areas of seismic interest and assuming a representative spread among the five USPS Service Regions. This latter combination identified 18 zone/regions that included all possible permutations of NEHRP Seismic Map Areas > 3 and USPS Service Region.

Set #1: The Most Numerous Building Types

Main offices (M), Classified Stations (S), and Classified Branches (B) are by far the most numerous USPS buildings. The total number in NEHRP Seismic Map Areas 3 through 7, the areas subject to Preliminary Evaluation is 11,048. The numbers of buildings in these areas are:

Main Office (M)	9,299
Classified Station (S)	1,168
Classified Branch (B)	581

Set #1 of the SSDB consists of 167 buildings: 10 buildings (at most) from each of the 18 zone/regions, selected to include:

1. Two buildings from each of the following five construction categories (FMS Type of Construction):

   a. Concrete
   b. Steel-frame
   c. Wood-frame
   d. Wood/brick combination
   e. Brick/block combination

2. In each of the above construction categories, one building from each of the following two area categories:

   a. $1{,}000 < \text{area} \leq 5{,}000$
   b. $5{,}000 < \text{area} \leq 25{,}000$

Only 132 buildings were available under these criteria because some zone/regions had no buildings in the designated construction/area categories. Therefore, 35 additional buildings were chosen, considering the distribution of the various

categories. This was done to extend the total SSDB to a total sample of 200 buildings.

Set #2: The "Special" USPS Buildings

There are relatively few of these buildings that should be regarded as "Special" in the building classification system of Section 2.3.1. The numbers of buildings in NEHRP Seismic Map Areas 3 through 7 in each "Special" type are.

USPS Headquarters (A)	2
USPS Regional Office (R)	10
USPS Field Divisions (D)	25
Sectional Center Facility (C)	14
Bulk Mail Facility (E)	11
Postal Data Center (Q)	4

The 33 selected buildings are:

a. All 6 of type A regardless of location
b. All 6 of type Q regardless of location
c. 21 buildings of types R, D, C, and E that are located in the 18 zone/regions.

The Sample Survey Questionnaire

Once the database buildings were selected, a questionnaire was used to verify and augment information in the FMS database.

For example, the Seismic Program requires such information as the number of stories and the structural system. The questionnaire was developed to verify the information in the FMS; to obtain information needed for the program cost forecast; to obtain general structural and nonstructural information; and to obtain a better definition of the structural system. The questionnaire, which is reproduced in Appendix B, had four parts:

1. A list of the basic identifying information as found in the FMS, the information to be verified

2. A list of questions concerning the age of the building, its occupancy, the number of stories, and the area of the building

3. A list of questions concerning architectural and mechanical features of the building

4. An identification of the building type according to sketches and descriptions that were attached to the questionnaire

The questionnaire was sent out to the USPS Divisions, distributed to the 200 buildings in the SSDB, and returned to the project consultants.

The information was then used to establish the SSDB used both to illustrate and field test the seismic evaluation program for existing buildings.

Appendix B: The Sample Survey Questionnaire

USPS FACILITIES MANAGEMENT SYSTEM (FMS) UPDATE QUESTIONNAIRE

PART A. Please verify the following information. If the current value of the item is correct, place a check in the "OK?" column. If incorrect, write the correct information under "CORRECTIONS."

FMS Item	Current Value	OK?	Corrections
1. P.O. Name	WAPATO	___	___
2. Unit Name	MAIN OFFICE	___	___
3. Street Address	307 S STATUS AVE.	___	___
4. County	YAKIMA	___	___
5. State & ZIP	WA 98951	___	___
6. USPS Region	5 WESTERN (SAN BRUNO)	___	___ (enter code only)
*7. Facility Type:	M MAIN OFFICE	___	___ (enter code only)
*8. Type of Bldg Construction	5 BRICK/BLOCK COMB	___	___ (enter code only)
9. Total Interior Square Feet:	5678	___	___

*If correction required, refer to the "PART A: CODE LISTINGS"

Part B. Please answer the following questions:

10. If known, in what year was the building built? ___

11. During an ordinary day, what is the approximate number of employees in the building at any one time? ___

12. During an ordinary day, what is the approximate number of customers in the building at any one time? ___

13. During an ordinary night, what is the approximate number of employees in the building at any one time? ___

14. Which statement below best describes the lowest story in the building? ___

(a) building has a full basement (no windows)
(b) building has a partial basement (windows look out on grounds
(c) building has no basement

15. How many full stories above the lowest (0 = none)? ___

16. How many penthouses does the building have (0 = none)? ___

(continued on reverse)

USPS FACILITIES MANAGEMENT SYSTEM (FMS) UPDATE QUESTIONNAIRE

PART B. Please answer the following questions:

17. What is the estimated gross floor area (square feet) of the main floor of the facility? ________

PART C. Circle Yes or No for each of the following items:

18.	Was the building built before 1933?	Yes	No
19.	Was the building built during or after 1933 but before 1976?	Yes	No
20.	Was the building built after 1976?	Yes	No
21.	Are there suspended or acoustical ceilings in bldg?	Yes	No
22.	Is there an overhead sprinkler system in the bldg?	Yes	No
23.	Are there elevators or lifts in the building?	Yes	No
24.	Are there overhead conveyors in the building?	Yes	No
25.	Are there optical character readers in the building?	Yes	No
26.	Are there bar code readers in the building?	Yes	No
27.	Are there lookout galleries in the building?	Yes	No
28.	Has there been an addition to the bldg. that accounts for more than 25% of the total gross floor area?	Yes	No

PART D. In an effort to more accurately describe the construction of the facility, please refer to the "PART D BUILDING TYPES LIST" and provide the following information (Please do not use the "PART A CODE LISTINGS"):

29. Please enter the code that best describes this facility: ______

30. If you answered "yes" to question 28, enter the code that best describes the addition to this facility: ______

PART E. Please sign and date below:

PRINTED NAME	TITLE	SIGNATURE	DATE

Thank you very much for providing this information. Please return the completed questionnaire no later than May 12, 1989 to:

Donald W. Evick, Design Division, Room 400
Facilities Department
475 L'Enfant Plaza West, SW
Washington, DC 20260-6412

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